START JUL 16 1993 (11)

Station #12

0029530

57

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 142546

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Geosciences	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: 81235	6. Cog. Engr.: J. A. Caggiano/C. J. Chou	7. Purchase Order No.: N/A
8. Originator Remarks: Approval/Release		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: 6/18/93

JUL 1993 RECEIVED EDMC

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-EN-AP-132		0	Interim-status Groundwater Quality Assessment Plan for the Single Shell Tank Waste Management Areas T and TX-TY	3EQ	1	1	10

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name (K) Signature (L) Date (M) MSIN	(J) Name (K) Signature (L) Date (M) MSIN	(G) Reason	(H) Disp.
2/1	1	Cog.Eng. J. A. Caggiano/C. J. Chou 7/14/93 H6-06 7/14/93 H6-06	~~J. A. Caggiano~~	~~4/~~ 1	~~1~~
2/1	1	Cog. Mgr. R. L. Jackson 7/14/93 H6-06	C. J. Chou 7/14/93	2/1	1
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2/1	1	T. L. Bennington H4-16 W. R. Thackaberry for T. L. Bennington 7-14-93	B. L. Vedder 7/14/93	2/1	1
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18.	19.	20.	21. DOE APPROVAL (if required)
J. A. Caggiano/C. J. Chou 7/14/93 7/14/93	~~K. R. Fecht~~ R. L. Jackson 7/14/93	R. L. Jackson 7/14/93	Ltr. No.
Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	Cognizant/Project Engineer's Manager / Date	[] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

9413151.2027

SUPPORTING DOCUMENT			1. Total Pages 54
2. Title Interim-Status Groundwater Quality Assessment Plan for the Single Shell Tank Waste Management Areas T and TX-TY		3. Number WHC-SD-EN-AP-132	4. Rev No. Rev. 0
5. Key Words Groundwater Quality Assessment Waste Management Areas T and TX-TY Single Shell Tank APPROVED FOR PUBLIC RELEASE 7-16-93 D. Solis		6. Author Name: J. A. Caggiano/ C. J. Chou J. A. Caggiano, C. J. Chou Signature Organization/Charge Code 81235/R4CED	

7. Abstract

Specific Conductance, one of the Indicator Parameters in 40 CFR 265 Subpart F, in downgradient wells 2-W10-17 and 2-W14-12 at Single Shell Tank (SST) Waste Management Area (WMA) TX-TY and 2-W10-15 at SST WMA T exceeds the Critical Mean for Specific Conductance calculated after background monitoring for four quarters. Under 40 CFR 265, a groundwater quality assessment plan is required to initiate a program to determine whether these RCRA facilities are affecting the quality of groundwater. This document presents the plan for implementing groundwater quality assessment monitoring under interim status (40 CFR 265).

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9. Impact Level 3EQ

7-16-93

10. RELEASE STAMP

OFFICIAL RELEASE BY WHC (11)
DATE JUL 16 1993
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A-6400-073 (11/91) (EF) WEF124

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Reference: WHC-CM-3-4

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Title Interim-Status Groundwater Quality Assessment Plan for the Single Shell Tank Waste Management Areas T and TX-TY

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Title of Journal NA

CHECKLIST FOR SIGNATORIES

Review Required per WHC-CM-3-4	Yes	No	Reviewer - Signature Indicates Approval Name (printed)	Signature	Date
Classification/Unclassified Controlled Nuclear Information	[]	[X]			
Patent - General Counsel	[X]	[]	S W BERGLIN	S W Berglin	7/1/93
Legal - General Counsel	[X]	[]			
Applied Technology/Export Controlled Information or International Program	[]	[X]			
WHC Program/Project	[]	[X]			
Communications	[]	[X]			
RL Program/Project	[X]	~~[X]~~	M.J. FURMAN	M J Furman	7/7/93
Publication Services	[X]	[]	LA BROWN	L A Brown	7/14/93
Other Program/Project	[]	[X]			

Information conforms to all applicable requirements. The above information is certified to be correct.

	Yes	No
References Available to Intended Audience	[X]	[]
Transmit to DOE-HQ/Office of Scientific and Technical Information	[]	[X]

Author/Requestor (Printed/Signature) Date
J. A. Caggiano/ C. J. Chou 6/29/93

Intended Audience
[] Internal [] Sponsor [X] External

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R. L. Jackson 6/29/93

INFORMATION RELEASE ADMINISTRATION APPROVAL STAMP

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BD-7600-062 (08/91) WEF074

Part 1

9413152.2029

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1.0 INTRODUCTION

Field specific conductance has exceeded the critical mean of this parameter in groundwater in downgradient wells 2-W10-17 and 2-W14-12 at single-shell tank (SST) waste management area (WMA) TX-TY and in downgradient well 2-W10-15 at SST WMA T during the November 1992 sampling. These exceedances have been independently verified in April 1993 and confirmed by data from the March 1993 sampling. Under interim-status groundwater monitoring (40 CFR 265, Subpart F), exceedance of the critical mean necessitates preparation of a groundwater quality assessment monitoring plan to determine whether these RCRA facilities are affecting the quality of groundwater. This document presents a single assessment monitoring plan for these two WMA that are located above the same plume of high conductivity in the groundwater in the northern part of the 200 West Area of the Hanford Site.

Although decommissioned in 1980, the SST are considered to be actively storing dangerous and extremely hazardous and radioactive wastes and have been designated as Resource Conservation and Recovery Act of 1976 (RCRA) facilities under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1989).

The 149 SST are located in seven WMA containing one or more tank farms (Figure 1). Each of these tank farms consists of a number of 75-ft-diameter reinforced concrete tanks with a single liner of either ASTM A283 Grade C or A201 Grade C (241-AX Tank Farm only) carbon steel. Schematic diagrams of the construction of tanks in the 241-T, 241-TX, and 241-TY tank farms are shown on Figure 2. Monitoring of the SST is discussed in Welty (1988); present status of each tank in each tank farm is reported monthly by Hanlon (1993).

The SST have not received waste since November 1980, and many ceased receiving waste earlier because of suspected poor tank integrity. Many of the SST have been interim-stabilized (i.e., had pumpable liquids removed so that only salt cake, sludge, and interstitial fluid remain) and/or interim-isolated (i.e., had pipes removed or blocked to prevent the inadvertent addition of waste). The SST are targeted for closure as RCRA treatment, storage, or disposal units (TSD). The Single Shell Tank Closure/Corrective Action Work Plan (DOE 1989) was submitted to the State of Washington Department of Ecology (Ecology) in 1989 and is presently undergoing revision. WMA T is in the 200-TP-6 Operable Unit and WMA TX-TY is in the 200-TP-5 Operable Unit. Both of these WMA are part of the T Plant Source Aggregate Area (DOE 1992).

2.0 BACKGROUND INFORMATION

Two of the SST WMA (T and TX-TY) are located several hundred feet west and southwest of the 221-T Building (T Plant), which was the first chemical processing plant to operate on the Hanford Site. These two WMA (T and TX-TY), in the northern part of the 200 West Area (Figure 3), contain the three tank farms listed below:

Tank Farm	Year Built	Tank Capacity (gal)	No. Tanks	No. Leakers
241-T*	1943-44	530,000	12	7
241-TX	1947-48	758,000	18	7
241-TY	1951-52	758,000	6	5

* Includes four 20-ft-diameter 200 series tanks that each held 55,000 gal.

The SST received high-level metal and first-cycle wastes from the chemical processing of uranium-bearing spent fuel rods. Metal waste contained 90% of the fission product radionuclides plus all the uranium and some plutonium. Spent fuel rods from reactors in the 100 Areas were processed using the Tri-Butyl Phosphate, REDOX, or PUREX processes and these wastes were sent to various tank farms. The history of tank farms, the wastes that were sent to each tank in various tank farms, and the types of waste and constituents in each are described in Anderson (1990). Additional information on the SST may be found in the groundwater monitoring plan and revision (Jensen et al. 1989; Caggiano and Goodwin, 1991).

Waste management operations have created a complex intermingling of the tank wastes. Nonradioactive chemicals have been added to the tanks while varying amounts of waste- and heat-producing radionuclides have been removed. In addition, natural processes have caused settling, stratification, and segregation of waste components. Waste was also cascaded (allowed to flow by gravity from one tank to another) through a series of tanks; cooling and precipitation of radionuclides and solids occurred in each tank of the cascade. Some of the supernatant from the last tank in a cascade was sent to cribs because of the shortage of tank capacity for storing high-level waste. As a result, it is very difficult to estimate the composition of the wastes contained in the tanks through operational records.

The three general waste forms in the SST are sludge, salt cake and liquid. Sludge consists of the solids (hydrous metal oxides) precipitated from the neutralization of acid wastes before their transfer to the SST. Salt cake consists of the various salts formed from the evaporation of water from the waste. Liquid also exists as supernate and interstitial liquid in the tanks.

The SST wastes consist primarily of sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate and phosphate; and hydrous oxides of iron and manganese. The radioactive components consist of fission product radionuclides (e.g., ^{137}Cs, ^{90}Sr, ^{99}Tc), activation products (e.g., ^{125}Sb, ^{60}Co) and actinide elements such as uranium, thorium, plutonium and neptunium.

Numerous other liquid effluent facilities surround these two WMA (Figure 3; Table 2-1) and any of these could have contributed to the degradation of groundwater quality. Nearly two billion gallons of liquid effluent containing essentially the same long-lived constituents were discharged to tank farms, but at much lower activity/concentration were discharged as low- level waste to the cribs, trenches, and ponds that surround these two WMA. The only known indicator species that would identify waste as having come from a SST are the very short-lived radionuclides that would have decayed to other progeny or a stable state since the waste was discharged to tanks or soils. Known unplanned releases in this area during past operations are documented in Table 2-2.

3.0 GEOLOGY AND HYDROGEOLOGY OF THE HANFORD SITE

3.1 GEOLOGY

The Hanford Site is in the Pasco Basin, a broad topographic and structural basin that is underlain by Miocene tholeiitic basalt of the Columbia River Basalt Group. The basalt erupted from north-northwest trending linear vent systems between 17.5 and 6 M yr ago and consists of numerous basalt flows (some of which are separated by interbedded tuffaceous clastic terrigenous sediments) that have been deformed into asymmetrical anticlines and broad, asymmetric nearly flat-bottomed synclines. Anticlinal ridges border the Pasco Basin on the north (Saddle Mountains), west (Yakima and Umtanum Ridges) and southwest (Rattlesnake Mountain and smaller ridges [brachyanticilines] along this same northwest trend). A broad, nearly north-trending monoclinal flexure separates thinner basalt of the Palouse Slope to the east from the thicker basalt and sediments of the Pasco Basin. Overlying the basalt are a series of interbedded fluvial and lacustrine silts, sands and gravels of the Pliocene Ringold Formation and Quaternary Hanford formation.

Basalt of the Columbia River Group is over 12,000 ft thick in the Pasco Basin and is divided into several formations, three of which are present in the Pasco Basin. The Elephant Mountain member, one of the youngest basalts within the Saddle Mountains Formation (the uppermost and youngest of basalt strata), underlies the 200 Areas of the Hanford Site and generally constitutes the bottom of the unconfined aquifer. Because the basalts have been deformed, the surface of the Elephant Mountain member dips south to southwest into the Cold Creek Syncline, but the top of the basalt is an irregular, partially eroded surface. Each basalt flow may consist of a dense interior where generally well-developed columnar jointing is sandwiched between a more rubbly flow bottom and a primary flow top breccia that also is generally rubbly. Many basalt flows, especially those in the Saddle Mountains Formation, are separated by tuffaceous interbedded sediments that represent fluvial deposition of sand, silt, and clay between eruptive episodes of Columbia River basalt volcanism. The rubbly flow top and flow bottoms of basalt units along with the interbedded sediments, where present, store and transmit water more readily than the dense interiors of basalt flows and constitute the confined aquifer system beneath the Hanford Site.

The Ringold Formation varies from zero thickness along Gable Mountain to several hundred feet thick beneath the Hanford Site in the Cold Creek Syncline. It is generally a few hundred feet thick beneath the 200 West Area, is present in much of the 200 East Area, but is absent in the northern part of the 200 East Area where it has been removed by erosion. The Ringold Formation consists of Miocene to Pliocene sand, gravel and silt deposited in fluvial and lacustrine environments within the Pasco Basin. Granule to cobble gravels with a sandy matrix dominate parts of the Ringold Formation, which was deposited in a broad braided stream (a braidplain). Cross bedded and laminated sands deposited in broad stream channels are also common. In places, laminated silts and fine sands were deposited as overbank deposits on floodplains. Plane to cross-laminated clay and silt with some fine sand units displaying soft-sediment deformation characterize the lacustrine units. Deposition in a fluvial environment where post-depositional erosion and truncation are common has resulted in sediments in which there can be extreme and abrupt changes in sedimentary materials because of the geometry of fluvially deposited units. Further details of the Ringold Formation deposits and their various facies geometries and histories may be found in Lindsey and Gaylord (1989) and Lindsey (1991).

The Quaternary Hanford Formation overlies the Ringold and consists of sand, gravel, and silt deposited by floodwaters arising from cataclysmic failures of ice-dammed lakes along the margin of a continental glacier during the Pleistocene. Floodwaters coursing across the plateau carved the coulees north and east of the Pasco Basin as meltwater river channels and deposited terrigenous sediments in hydraulically dammed waters north of Wallula Gap. Facies within the Hanford formation consist of coarse granule to boulder gravel with little matrix (often openwork gravels) and varying bedding, fine to coarse grained sand and granule gravel exhibiting plane lamination and bedding and some channel filling as well as thinly bedded, plane laminated and ripple cross-laminated silt and fine to coarse sand. These sediments reflect deposition in sedimentary environments of varying energy, from high-energy main channels to low-energy slackwater and back flooded settings. Further detail may be found in Lindsey (1991).

Thin fine-grained units of limited vertical and lateral extent may be found in all the units of the Ringold and Hanford Formations and can be significant in their affect on the migration of fluids in the vadose zone as well as in groundwater and contaminant transport.

Separating the Ringold and Hanford Formations in the 200 West Area are two units that can have a significant effect on the transport of contaminants. The Plio-Pleistocene unit is a laterally discontinuous paleosol developed atop the Ringold and can be massive, densely calcareously cemented silt and sand with some gravel. Caliche-rich to caliche-poor silts and sands may be interbedded in this unit, which can be moderately to highly fractured.

Overlying the Plio-Pleistocene horizon may be a compact, massive loess-like silt with minor fine sand. Called the early "Palouse soil", the unit can be several to a few tens of feet thick and can grade upward transitionally into similar material at the base of the Hanford formation.

Both of these units are present beneath WMA T and WMA TX-TY. Cross sections beneath WMA T and TX-TY are shown on Figures 4 and 5. Further details of the geology of the 200 West Area can be found in Lindsey (1991).

Topography within the Pasco Basin reflects erosion and deposition by periodic cataclysmic floods during the Quaternary and minor reworking of Pleistocene units by Holocene stream and wind action. The "200 Area Plateau" is a sand and gravel bar deposited in hydraulically dammed floodwaters in the basin north of the constriction at Wallula Gap. This expansion bar developed downstream of the constriction of floodwaters at Sentinel Gap.

3.2 HYDROGEOLOGY

Groundwater is contained in an unconfined aquifer in the Hanford and Ringold Formations and in a confined aquifer system in the Columbia River basalt, which generally constitutes the base of the unconfined aquifer. Where silt-rich units occur in 200 West Area (e.g., the Lower Mud Sequence in the Ringold Formation) they function as a semiconfining bed for groundwater in the gravels at the base of the Ringold. Depth to groundwater varies with location on the Hanford Site, but is generally 200 to 300 ft beneath the "200 Area Plateau" where the separations areas are located.

Natural recharge of the unconfined aquifer by precipitation is minimal because of low rainfall and high evapotranspiration. Evapotranspiration at the Hanford Site varies with the season and the type of soil and vegetation. Recharge by infiltration of rainfall has been estimated ranging from 4 cm/yr (Gee and Kirkham, 1984) where the ground surface is unvegetated gravel (e.g., in tank farms where a gravel armor has been placed to restrict the growth of vegetation and to minimize deflation of contaminated soils) to up to zero where fine grained vegetated soils occur (Routson and Johnson, 1990). Evapotranspiration is minimal when a significant portion of the annual rainfall occurs at the Hanford Site (November through February), but unless that rainfall infiltrates beyond the depth of root penetration, it is available for uptake by plants and much (if not all) will be lost in evapotranspiration. For environmental and worker safety, vegetation in tank farms is controlled so that buried radiation is not returned to the surface where it can present a hazard. Therefore, all rainfall infiltrates through the gravel armor and can infiltrate unimpeded. Poorly sealed wells can provide a pathway for precipitation or melting snow that can infiltrate deep into the vadose zone, thus enhancing groundwater recharge beyond that occurring from infiltration by interstitial transport.

Artificial recharge to the unconfined aquifer through disposal of liquid effluent has been estimated at up to 10 times natural recharge (Graham 1981) during past operations and has resulted in raising the water table more than 70 ft compared with its elevation in pre-Hanford years (Bierschenk 1957). As facilities shut down and cease to discharge large volumes of liquid waste to the ground, artificial recharge is diminishing and is less than 10 times natural recharge. Fine grained units in the Ringold may serve as perching horizons that retard the infiltration of water through the vadose zone to groundwater. The unconfined aquifer discharges to the Columbia River.

Recharge of the confined aquifer system occurs through infiltration of precipitation in aquifers exposed in the basalt ridges in and along the margins of the Pasco Basin. Some recharge to the uppermost confined system may occur where there is a hydraulic connection between the unconfined and confined aquifer systems and where the head in the unconfined system exceeds that in the confined system. Where the head in the confined system exceeds that in the unconfined aquifer, the unconfined aquifer may be recharged along hydraulic connections between the two systems.

4.0 DESCRIPTION OF EXISTING GROUNDWATER MONITORING SYSTEM

4.1 MONITORING WELL NETWORK

Groundwater beneath all SST WMA is monitored for RCRA in accordance with the requirements specified in WAC 173-303-400 (and by reference, requirements found in 40 CFR 265, Subparts F through R). Although the groundwater regulations in 40 CFR 265, Subpart F are not applicable per se to RCRA tank units, DOE-RL has agreed to install and operate a groundwater monitoring system at the SST via terms established in Ecology et al. (1989). Thus, the interim status regulations of 40 CFR 265, Subpart F will be considered relevant for purposes of this groundwater assessment plan. Interim status groundwater monitoring at WMA T and TX-TY (241-T, 241-TX, and 241-TY tank farms) was initiated in 1989 with the preparation of a groundwater monitoring plan (Jensen et al. 1989) and the construction of the first group of RCRA standard wells around the T Tank Farm. There are presently four RCRA standard wells at each of these WMA. The older wells are constructed of carbon steel casing and are being used to provide supplemental water level data. RCRA standard wells 2-W10-15, 2-W10-16 (an upgradient well), 2-W11-27, and 2-W11-28 (Figure 3) monitor the groundwater quality beneath WMA T and were constructed at locations specified in the groundwater monitoring plan and revision (Jensen et al. 1989; Caggiano and Goodwin, 1991). RCRA standard wells 2-W10-17, 2-W10-18, 2-W14-12, and 2-W15-22 (an upgradient well) monitor the groundwater quality beneath WMA TX-TY. Specifications regarding RCRA groundwater monitoring wells are given in Table 4-2a as well as in the as-built diagrams in Appendix A.

All the wells used for RCRA sampling and analysis were constructed to comply with WAC 173-160 and are called RCRA standard wells (Ecology/EPA, 1990). A RCRA standard well is constructed of nonreactive casing and screen (stainless steel for Hanford wells), includes a filter pack surrounding the screen that penetrates the upper 15 ft of the unconfined aquifer and includes a full annular and surface seal. All of these wells are located outside the perimeter fences of tank farms and at least 100 ft from the nearest tank (per agreement with Ecology). As-built construction diagrams for each of the RCRA standard wells at WMA T and WMA TX-TY are in Appendix A.

Well 2-W11-28 was constructed in 1991, but has not been sampled since May 1992. The single sample taken in May had a 170 nephelo-metric turbidity units (NTU) and the data were judged to be not usable. No statistical analyses have been performed on any data from well 2-W11-28. Statistical evaluations are based on three wells for WMA T. The 4-in. stainless steel casing in this well was bent (kinked) during completion of the well. Remediation of this well is in progress. If this well cannot be recovered by July 1993, the well will be replaced. At present, WMA T is out of compliance with RCRA requirements to have at least one upgradient and at least three downgradient wells at each facility. There is one upgradient well (2-W10-16) and two downgradient wells that can be sampled at WMA T (2-W10-15 and 2-W11-27).

Initial sampling of wells 2-W10-15 and 2-W10-16 began in February 1990, but sampling was halted until July 1991 because of the absence of analytical laboratory support. Sampling was resumed in July 1991 at wells 2-W10-15, 2-W10-16, 2-W10-17, 2-W10-18, and 2-W15-22 and continued quarterly until at least four quarters of data were obtained to use in calculating background. Sampling of wells 2-W11-27, 2-W11-28, and 2-W14-12 began in 1992. Background values for some of the SST WMA are in the 1993 annual report (Caggiano 1993). The groundwater samples from these wells have been analyzed for indicator parameters, drinking water standards, water quality parameters and site specific constituents (^{137}Cs, ^{90}Sr, ^{60}Co, ^{129}I, ^{3}H, total uranium, total plutonium and a gamma scan) in accordance with 40 CFR 265, Subpart F and/or groundwater monitoring plans. Results of these analyses may be found in various quarterly reports (DOE-RL 1991, 1992b, 1992c, 1992c, 1992e, and 1993c). Groundwater monitoring at the SST is also discussed in an annual report of groundwater monitoring of all RCRA facilities on the Hanford Site (DOE-RL 1993a).

Numerous older wells that pre-date the application of RCRA regulations at the Hanford Site are present in and around these two WMA. These wells were constructed during the period of 1948 to 1974 either to monitor adjacent cribs or to check for possible effects of the largest known leak from an SST (the 1973 leak of 115,000 gal from the 241-T-106 tank). These wells are constructed of carbon steel with no surface or annular seal (some have had surface and/or annular seals added some time after original construction of the well) and generally have casing perforated over a lengthy interval in the uppermost aquifer (Table 4-2a). A few of the wells constructed in 1973 and 1974 have screens. Some of these wells are used to supply water level data to supplement the water level measurements made in RCRA standard wells at the time of sampling.

Several of these older wells in or around these tank farms are sampled as part of the Westinghouse Hanford Company (WHC) Environmental Surveillance program; 2-W10-1, 2-W10-3, 2-W11-24 at WMA T, and 2-W14-6 and 2-W15-3 at WMA TX-TY. Analytical data from environmental surveillance monitoring are compared with administrative control values (ACV) and derived concentration guidelines (DCG) for various analytes for compliance with DOE Order 5480.2. Concentrations/activities for ACV and DCG are different than those in 40 CFR 265; there are ACV and DCG for radionuclides that are not specified in the RCRA standards.

4.2 GROUNDWATER QUALITY

Results of the November 1992 sampling indicate that downgradient wells 2-W10-15 at WMA T and 2-W10-17 and 2-W14-12 at WMA TX-TY exceed the critical mean for specific conductance calculated for each WMA after four or more quarters of background monitoring (Figure 6 and 7). This increase was confirmed by verification sampling and necessitates preparation of a groundwater quality assessment plan under 40 CFR 265.93(d)(2) and the initiation of a program to determine whether these two SST WMA are influencing the quality of groundwater. Detailed information for statistical evaluation is presented in Section 4.4 and Appendix B.

Although the critical mean for specific conductance for each WMA is different, the two WMA are situated above a plume of high specific conductance in groundwater in the northern part of the 200 West Area (see Figure 5-37 in Johnson 1993) that extends well beyond the area of these two WMA, in both upgradient and downgradient directions. Because of the proximity of these two WMA, receipt of similar wastes, and their location above the same plume of groundwater with high conductivity, a single assessment monitoring plan is being prepared to better define the extent of the plume and to determine whether wastes leaked/spilled from the SST may have contributed to the degraded quality of groundwater.

Analytical data from RCRA sampling indicate that nitrate, chloride, fluoride, sulfate, sodium, and calcium are elevated in the groundwater in this area. Groundwater beneath WMA T and TX-TY has also been found to have elevated tritium, ^{99}TC and gross beta (see DOE quarterly reports DOE-RL 1991, 1992b, 1992c, 1992d, 1992e, 1993c). Some of these constituents may account for the high conductivity detected in the groundwater. All of these constituents were significant components of wastes discharged to both the SST and to the numerous liquid effluent facilities in the vicinity of WMA T and TX-TY.

Maps (Connelly et al. 1992) reveal that the areal extent of various constituent plumes in groundwater far exceeds the areas directly beneath the 241-T, 241-TX, and 241-TY Tank Farms and suggests that many other facilities may have contributed to the degradation of groundwater quality. Poorly sealed older carbon steel wells in the vicinity of tank farms, especially those constructed adjacent to cribs, may have contributed to aquifer contamination because of the absence of an annular seal. Water collecting at the ground surface (e.g., melting snow) could flow down a poorly sealed well, or fluids could infiltrate part of the way to groundwater along an unsealed well until they reached a perching horizon and then transported laterally to another unsealed well. In this way, at least some waste constituents may have been transported to groundwater through means other than interstitial fluid flow. Partial annular seals were installed in some older wells in the 1970's when it became apparent that unsealed wells could serve as a direct pathway to groundwater.

4.3 GROUNDWATER SAMPLING AND ANALYSIS STATUS

The groundwater beneath WMA T and TX-TY has been monitored quarterly since July and September, 1991, respectively. Wells 2-W10-15 and 2-W10-16 were constructed in 1989 and first sampled in February 1990, but sampling was discontinued because a supporting analytical laboratory was not available. Since 1991, wells have been sampled quarterly for indicator parameters, drinking water standards, water quality parameters, and site specific constituents in order to obtain background information. Background monitoring was completed at WMA T and WMA TX-TY in July 1992. All available data on groundwater monitoring have been published in quarterly reports of groundwater monitoring at RCRA facilities on the Hanford Site.

4.4 STATISTICAL EVALUATION OF GROUNDWATER DATA

4.4.1 Summary of Background Information

The background well for the SST WMA TX-TY is 299-W15-22. Four quarters of monitoring data were collected on September 1991, January, April, and July 1992. The July 1992 data completes the requirements to "establish initial background concentrations ... quarterly for one year" for downgradient wells 299-W15-22, 299-W10-17, and 299-W10-18 [40 CFR 265.92(c)(1)]. The March 1993 data completes this requirement for downgradient well 299-W14-12.

The background well for the SST WMA T is 299-W10-16. Initial groundwater samples were collected on February 1990, but subsequent sampling was discontinued because of the lack of an analytical laboratory. Sampling resumed in July 1991 and was conducted quarterly thereafter in September 1991, January, April, and July 1992. The July 1992 data completes the requirement to "establish initial background concentrations ... quarterly for one year" for wells 299-W10-16 and 299-W10-15 [40 CFR 265.92(c)(1)]. The March 1993 data completes this requirement for well 299-W11-27. Well 299-W11-28 was not used in the subsequent statistical analysis due to reasons explained earlier.

Regulations [40 CFR 265.92(c)92)] require that "For each of the indicator parameters ... at least four replicate measurements must be obtained for each sample". This requirement was met.

Tables 4-2a and 4-2b give the raw data, including data from upgradient (background) and downgradient (compliance) wells. Tables 4-3a and 4-3b give the replicate averages in the background using data from upgradient wells. Tables 4-4a and 4-4b give the background summaries for the replicates in the background. Note that in this report letters a and b (after a given table number) are used to denote SST WMA TX-TY and SST WMA T, respectively.

4.4.2 Statistical Method

The method used to summarize the background data is the averaged replicate (AR) t-test method as described in Appendix B of the *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (TEGD) (EPA 1986a). The AR t-test method, for each contamination indicator parameter, is calculated as:

$$t = (\overline{x}_i - \overline{x}_b)/S_b * \sqrt{1+1/n_b}$$

where:

t = test statistic
$\overline{x}_i$ = average of replicates from the ith monitoring well
$\overline{x}_b$ = background average
S_b = background standard deviation
n_b = number of background replicate averages.

The TEGD states that there is a statistically significant indication of contamination if the test statistic is larger than the Bonferroni critical value (t_c); i.e., $t > t_c$. These Bonferroni critical values depend on the overall false-positive rate required for each sampling period (i.e., 1% for interim-status), the total number of wells in the monitoring network, and the number of degrees of freedom (n_b - 1) associated with the background standard deviation. Because of the nature of the test statistic in the above equation, results to be compared to background do not contribute to the estimate of the variance. The test can be reformulated, without prior knowledge of the results of the sample to be compared to background (i.e., $\overline{x}_i$), in such a way that a critical mean (CM) can be obtained:

$$CM = \overline{x}_b + t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(one-tailed)}$$
$$CM = \overline{x}_b \pm t_c * S_b * \sqrt{(1+1/n_b)} \quad \text{(two-tailed)}$$

For pH, a two-tailed critical mean (or critical range) is calculated and a one-tailed critical mean is calculated for specific conductance, total organic carbon (TOC), and total organic halogen (TOX). The critical mean (or range, for pH) is the value above (or above/below which in the case of pH), a compared value is determined to be statistically different from background. Tables 4-5a and 4-5b list background average, background standard deviation, and critical mean (or critical range, in the case of pH) for the contamination indicator parameters except for TOX because of unsatisfactory audit findings of the DataChem Laboratories, DOE-RL 1993b).

4.4.3 Comparison of the November 1992 Data to Background

Tables 4-6a and 4-6b list contamination indicator parameter data collected from the monitoring network for WMA TX-TY and WMA T, respectively, in November 1992 and Tables 4-7a and 4-7b give the statistical summaries for the replicates. Note that TOX data listed in Tables 4-7a and 4-7b is for the purpose of completeness only. It is not used for the background/compliance well comparisons because of unsatisfactory audit findings (DOE-RL 1993b).

Comparison of the replicate averages from Table 4-7a against the critical means in Table 4-5a indicates that specific conductance in downgradient wells 299-W10-17 and 299-W14-12 (WMA TX-TY) is statistically higher than the background critical mean. A specific conductance concentration versus time plot for the SST WMA TX-TY is presented in Figure 7. As shown from Figure 7, downgradient well 299-W14-12 only has three quarters of monitoring data as of November 1992; however, specific conductance is consistently higher than the critical mean, 667.4 μmho/cm.

Similarly, comparison of the replicate averages from Table 4-7b against the critical means in Table 4-5b indicates that specific conductance in downgradient well 299-W10-15 is statistically higher than the background critical mean, 1,174.6 μmho/cm. A specific conductance concentration versus time plot for the SST WMA T is shown in Figure 6.

4.4.4 Results of Verification Sampling

The regulations [40 CFR 265.93(c)(2)] allow the owner/operator to resample a well to determine if the significant difference was a result of "laboratory" error. Wells 299-W10-17, 299-W14-12, and 299-W10-15 were resampled twice (by WHC sampling team) for specific conductance on April 29, 1993. Independent measurements by another sampling team are deemed unnecessary because specific conductance levels have been consistently high since the monitoring began (Figures 6 and 7). The resampling results are presented in Table 4-8a and the replicate averages are presented in Table 4-9a for the SST WMA TX-TY.

Comparison of the replicate averages for the two sets of verification samples (Table 4-9a) have confirmed that specific conductance in wells 299-W10-17 and 299-W14-12 exceed the critical mean and that the SST WMA TX-TY may be affecting the quality of the groundwater.

The averages of the quadruplicate field analyses (well 299-W10-15) performed by WHC sampling team (on April 29, 1993) fell just below the critical mean for the SST WMA T. Later, specific conductance data resulting from the scheduled March 1993 sampling became available. Average of the quadruplicate analyses for the March 5, 1993, sampling fell slightly above the critical mean, 1,174.6 µmho/cm. The resampling results (including the March 1993) data are presented in Tables 4-8b and the replicate averages are presented in Table 4-9b.

Instead of collecting another set of data for the second round of verification sampling for the SST WMA T, the March 1993 data serves as confirmation that the specific conductance in well 299-W10-15 is statistically above background for the reason given below:

- These sites are located very close (about 185 m) to one another in the northern part of the 200 West Area.
- The monitoring program for the SST WMA TX-TY is going to be shifted to assessment level due to elevated levels of specific conductance in downgradient wells, 299-W10-17 and 299-W14-12.
- The two SST WMA are situated above the same extensive plume of high specific conductance in groundwater (see Figure 5-37, Johnson 1993).

It has not been determined that the high specific conductance found in wells 299-W10-17, 299-W14-12, and 299-W10-15 is due to contamination from these two WMA. Influence from other sources could exist (e.g., 216-T-5 through T-25 trenches, see Table 2-1). A single groundwater assessment program will address the possible causes for the elevated specific conductance in downgradient wells 299-W10-17, 299-W14-12, and 299-W10-15.

5.0 GROUNDWATER QUALITY ASSESSMENT PROGRAM

The objective of this groundwater quality assessment program is to determine whether any mixed waste (i.e., dangerous or extremely hazardous waste and/or radioactive waste) that leaked or spilled to the ground from SST in WMA T and TX-TY has reached groundwater and contributed to the degradation of the quality of groundwater in the vicinity of these SST. To accomplish this, several tasks are proposed:

- Assess the extent of the plume of elevated specific conductance in groundwater that occurs beneath WMA T and TX-TY.

- Evaluate results of analyses of groundwater samples (RCRA wells as well as historic sampling data) to determine, to the extent possible, the specific constituents that have caused the elevated specific conductance.

- Evaluate the constituents in the waste streams that fed the SST in WMA T and TX-TY as well as those that fed surrounding liquid effluent disposal facilities to determine whether the specific constituents causing the elevated conductivity could have come from the SST or any of the surrounding facilities.

- Determine whether the SST are affecting the quality of groundwater beneath WMA T and TX-TY. If so, continue quarterly sampling through closure; if not, return to detection monitoring. Recommend actions that might be needed prior to closure of these SST WMA.

- Prepare an assessment report documenting the above steps for transmittal to Ecology.

Groundwater contaminant plumes in the northern part of the 200 West Area (Connelly et al. 1992; Johnson 1993) are areally extensive and cover areas much larger than these two SST WMA. Furthermore, the peak concentration/activity of some of the contaminants is not directly beneath or in the vicinity of WMA T or TX-TY. The areal extent of the contaminant plumes suggest that any of numerous liquid effluent disposal facilities surrounding these two facilities (Table 2-1 and Figure 3) may have contributed to degradation of groundwater quality in the northern part of the 200 West Area, and that includes the groundwater, which occurs directly beneath and adjoining these two facilities. Any combination of the cribs, ditches, trenches, ponds, and reverse wells in the vicinity of these two WMA as well as the leaking tanks in the 241-T, 241-TX, and 241-TY tank farms could have contributed contaminants to groundwater either by interstitial transport of fluids to groundwater, by transport along poorly sealed wells, by remobilization of previously leaked/spilled wastes, or some combination of these. Although different in concentration/activity at the time of discharge, the waste streams feeding these facilities contained nearly identical constituents so that the facility responsible for groundwater contamination is difficult to identify. The focus of investigation for this assessment monitoring program is to determine whether the SST in WMA T and TX-TY have affected the quality of groundwater beneath these two RCRA facilities. Other investigations associated with closure of the tank farms may be broader in scope so as to address the source facilities that are responsible for the areally extensive plumes of contaminants in the northern part of the 200 West Area that extend beneath these two WMA. The assessment report completed at least 1 yr after implementing this groundwater quality assessment program may further address the issue of other facility contributions to groundwater contamination.

Work performed in addressing these objectives will be controlled by the requirements of WHC (1988a) and WHC (1992). Sampling will be performed by Pacific Northwest Laboratory (PNL) field crews and analyses will be performed by International Technology Analytical Services (ITAS) (for radionuclides) and DataChem Laboratories (DCL) (for hazardous constituents) using quality control measures stipulated in the WHC contract with PNL and PNL procedures approved by WHC as necessary (see Sections 5.6 and 6.0 through 6.2). Sampling and analyses will continue to follow the RCRA protocol. If there are any changes to these plans, Ecology will be notified and consulted for mutual consensus prior to implementation of any new course of action or change in schedule.

5.1 INVESTIGATION REPORT

Quarterly sampling for indicator parameters, drinking water standards, and groundwater quality parameters will continue for the RCRA standard wells presently in the sampling network for WMA T and TX-TY. Construction of additional RCRA standard wells is not planned at this time. The only well that might be added to the present RCRA monitoring network around these two WMA would be as a replacement for downgradient well 2-W11-28, should that well not be able to be remediated to become suitable for RCRA sampling and analyses.

5.2 GROUNDWATER QUALITY ASSESSMENT MONITORING NETWORK

To better define the areal extent of the plume of high conductivity in groundwater in the northern part of the 200 West Area, the sampling network will be expanded beyond the immediate area of the tank farms (as it is presently configured) to include other suitably located existing wells. Where available, RCRA standard wells for other facilities such as the Low-Level Burial Grounds will be used to acquire data by co-sampling mutually agreed upon by the two projects to maximize efficiency and minimize cost. Older carbon steel wells will be evaluated for their suitability to provide data representative of the groundwater in the shallow unconfined aquifer. Carbon steel wells suitably located to provide appropriate data will be evaluated for seals, open interval, screen or perforations, adequate development and sampling device. If necessary, any older carbon steel wells may be remediated by scrubbing, cleaning, re-development and installation of a suitable sampling pump (submersible or otherwise) to assure that the well can be appropriately sampled to yield samples representative of the groundwater in the shallow unconfined aquifer and that can be compared with data from RCRA sampling. Suitable data gathered by other WHC programs (such as the Environmental Surveillance and Operational networks) will be used if the quality of the data is suitable for comparison to data gathered using RCRA protocol.

Supplementary sampling from other non-RCRA wells will include constituents considered likely to contribute to elevated specific conductance in groundwater. Samples will be analyzed for suspect anions such as nitrate, sulfate, phosphate, chloride, and fluoride as well as metals such as sodium, calcium, copper, magnesium, manganese, nickel, and aluminum. In addition, samples will be analyzed for radionuclides or any other constituents that might serve to distinguish specific source facilities or that could be causing elevated specific conductance. Analyses for radionuclides will include ^{129}I, ^{60}Co, ^{137}Cs, ^{90}Sr, ^{241}Am, ^{152}Eu, ^{154}Eu, as well as gross plutonium and uranium.

Historical data from the sampling and analyses of older wells in the vicinity of these three tank farms will be examined to determine whether there are any data that contribute to the identification of the source facilities responsible for the elevated conductivity in groundwater. These data will provide information that may prove beneficial in the selection of additional groundwater monitoring wells to use in the expanded network planned for assessment groundwater monitoring.

5.3 WATER TABLE MEASUREMENTS

Water levels will be measured in all wells that are sampled to assure the configuration of the water table and to be able to determine the direction of flow of groundwater. Any older wells that are to be used will be re-surveyed to a common datum so that measured water levels are comparable to those measured in RCRA standard wells and the supplementary water level wells.

5.4 GROUNDWATER QUALITY ASSESSMENT SAMPLING SCHEDULE

The RCRA standard wells in the groundwater monitoring networks for WMA T and TX-TY will continue to be sampled quarterly for indicator parameters, drinking water standards, groundwater quality parameters and site specific constituents. The analyses will be tailored to identify specific anions and cations that may be producing the elevated conductivity. Radionuclides that could help target the facilities, which are the source of the contaminants contributing to elevated conductivity will also be analyzed in these quarterly samples.

5.5 SCHEDULE OF IMPLEMENTATION

Quarterly monitoring of RCRA standard wells will continue throughout the assessment program. During the first quarter, additional wells will be considered for addition to the network for assessment monitoring. Any evaluation/remediation of these wells will be planned so that these wells are ready for quarterly sampling as soon as is possible given the available resources. The expanded network will be sampled for at least four quarters prior to preparation of an assessment report that will document the results of the assessment monitoring program.

5.6 SAMPLING AND ANALYSIS METHOD

The procedure for groundwater sample collection, water level measurements and field measurements are contained in PNL (1989). The following list contains specific applicable procedures:

- FA-1 "Temperature Measurement Procedure"
- FA-2 "Calibration of Conductivity Meter and Measurement of Field Conductivity"

- FA-3 "Calibration of pH Meter and Measurement of Field pH"
- GC-1 "Groundwater Sample Collection Procedure"
- GC-2 "In-Line Sample Filtration Procedure"
- GC-3 "Disposal of Purge Water From Monitoring Wells"
- WL-1 "Water Level Measurement Procedure"
- WL-2 "Procedure of Standardizing Steel Tapes."

Chain-of-custody procedures are contained in procedure AD-2, Groundwater Sample Chain-of-Custody Procedure (PNL 1989). The history of the custody of each sample is documented according to this procedure.

Preservation techniques, analytical methods used, and current detection levels of the constituents sampled for at the SST WMA are in accordance with EPA (1986b); or approved standard methods and listed in the quality assurance project plan (QAPP) for *RCRA Groundwater Monitoring Activities* (WHC 1992).

6.0 QUALITY ASSURANCE PROGRAM

Overall quality assurance (QA) program requirements are defined by WHC (1988) and Ecology et al. (1989) Article 30. The RCRA sampling and analysis program is being performed by PNL in support of waste management activities conducted by WHC for DOE. Sample collection and analysis activities are conducted under guidelines in WHC (1992). The laboratory that analyzes the RCRA samples for hazardous chemicals is currently DCL. ITAS Richland, Washington, performs the radiochemical analyses. Both laboratories are subcontracted to PNL. The quality control (QC) and QA specific laboratory procedures are based on *Testing Methods for Evaluating Solid Wastes* (EPA 1986b). These programs are designed to meet requirements of *Interim Guidelines and Specifications for Preparation of Quality Assurance Project Plans* (EPA 1983).

6.1 INTERNAL QC OF PARTICIPANT CONTRACTOR OR SUBCONTRACTOR LABORATORY

Internal QC at the participant contractor, or subcontractor laboratories include general practices applicable to a wide range of analyses, as well as specific procedures stipulated for particular analyses as outlined in the QAPP (WHC 1992). Each laboratory generating data has the responsibility to implement minimum procedures that assure that precision, accuracy, completeness, and respresentativeness of its data are known and documented (EPA 1983). All laboratories shall have a written plan covering their analytical methods and samples, calibration standards and devices, and reagent checks. The services of alternate analytical chemistry laboratories may be procured for split sample analyses.

6.2 EXTERNAL QC

The external QC will use both interlaboratory comparisons and blind, duplicate, and blank samples, to evaluate for accuracy, precision, and contamination of results from the participant contractor, or subcontractor laboratory. More specific requirements for external QC can be found in the QAPP (WHC 1992). A summary of this evaluation is provided in the RCRA quarterly reports.

7.0 RECORD KEEPING AND REPORTING REQUIREMENTS

A letter report stipulating the progress on identifying and evaluating additional wells for the network will be prepared and submitted to Ecology prior to initiating sampling of the expanded network. After quarterly sampling of the expanded network for at least 1 yr, an assessment report will be prepared documenting the data and interpretations of the expanded network and making any appropriate recommendations for future action. Future action could include further expansion and evaluation of the network or return to detection level monitoring if WMA T and TX-TY are not affecting the quality of groundwater. The assessment report will be prepared after data from at least 1 yr of quarterly sampling of the expanded network are received and interpreted. Quarterly sampling data and water level measurements will continue to be reported in Hanford Site quarterly reports on RCRA groundwater monitoring. Groundwater monitoring at all SST is also discussed in annual reports for all RCRA facilities on the Hanford Site.

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Figure 1. Map of the 200 West Area Showing SST WMA.

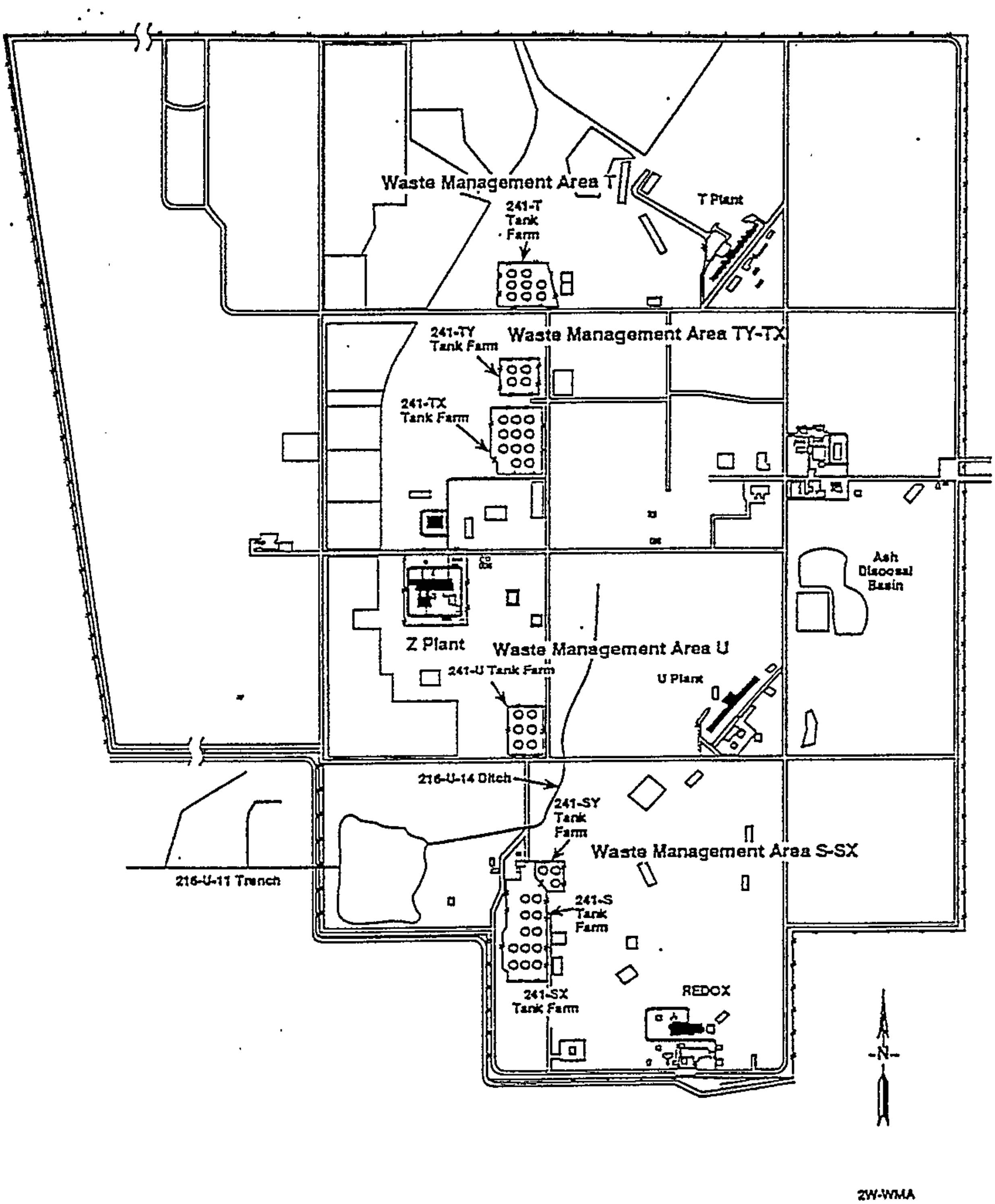
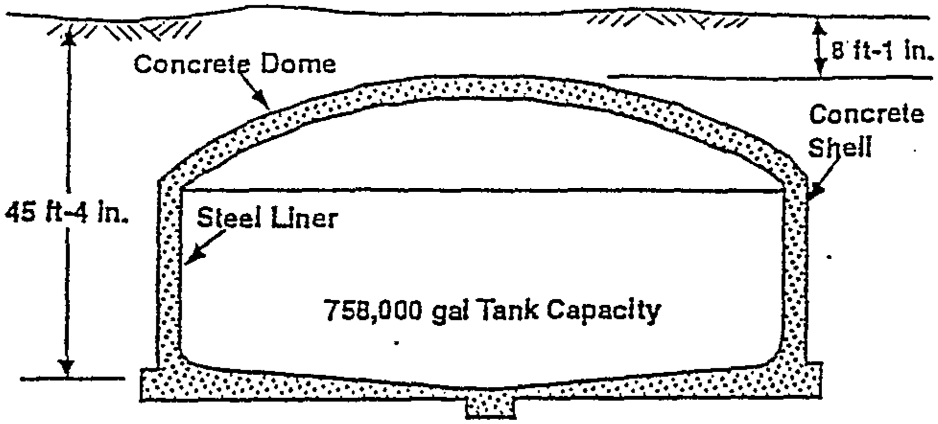
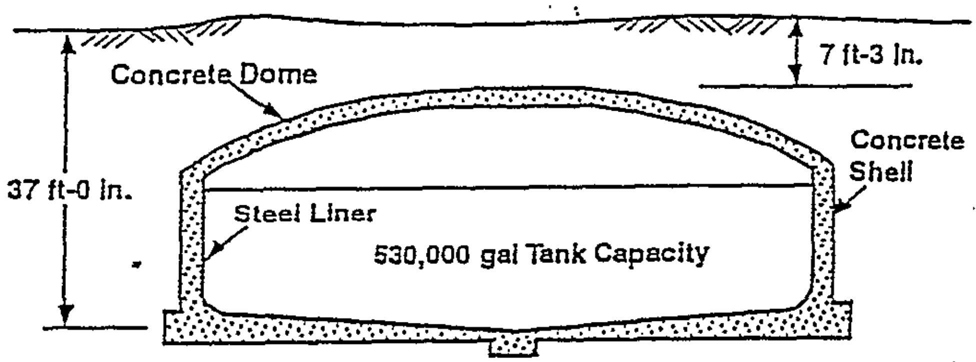


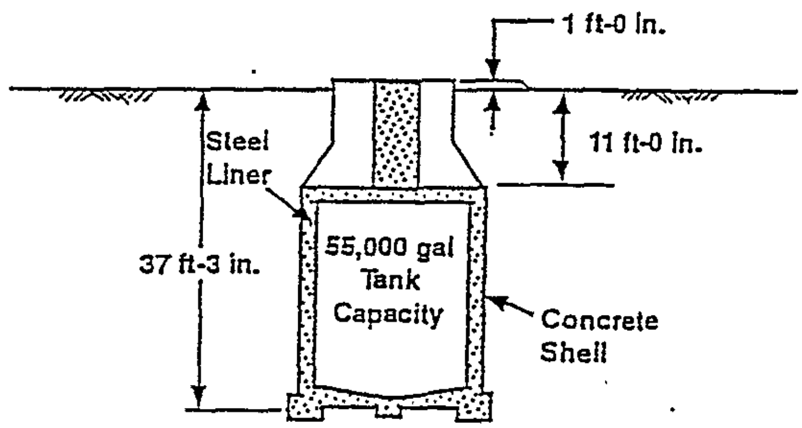
Figure 2. Schematic Diagrams of Construction of SST in WMA T and TX-TY. (from Hanlon, 1993)



75 ft Diameter Single-Shell Tank
Tank Farms: BY, S, TX, TY



75 ft Diameter Single-Shell Tank
Tank Farms: B, BX, C, T, U



20 ft Diameter Single-Shell Tank
Tank Farms: B, C, T, U

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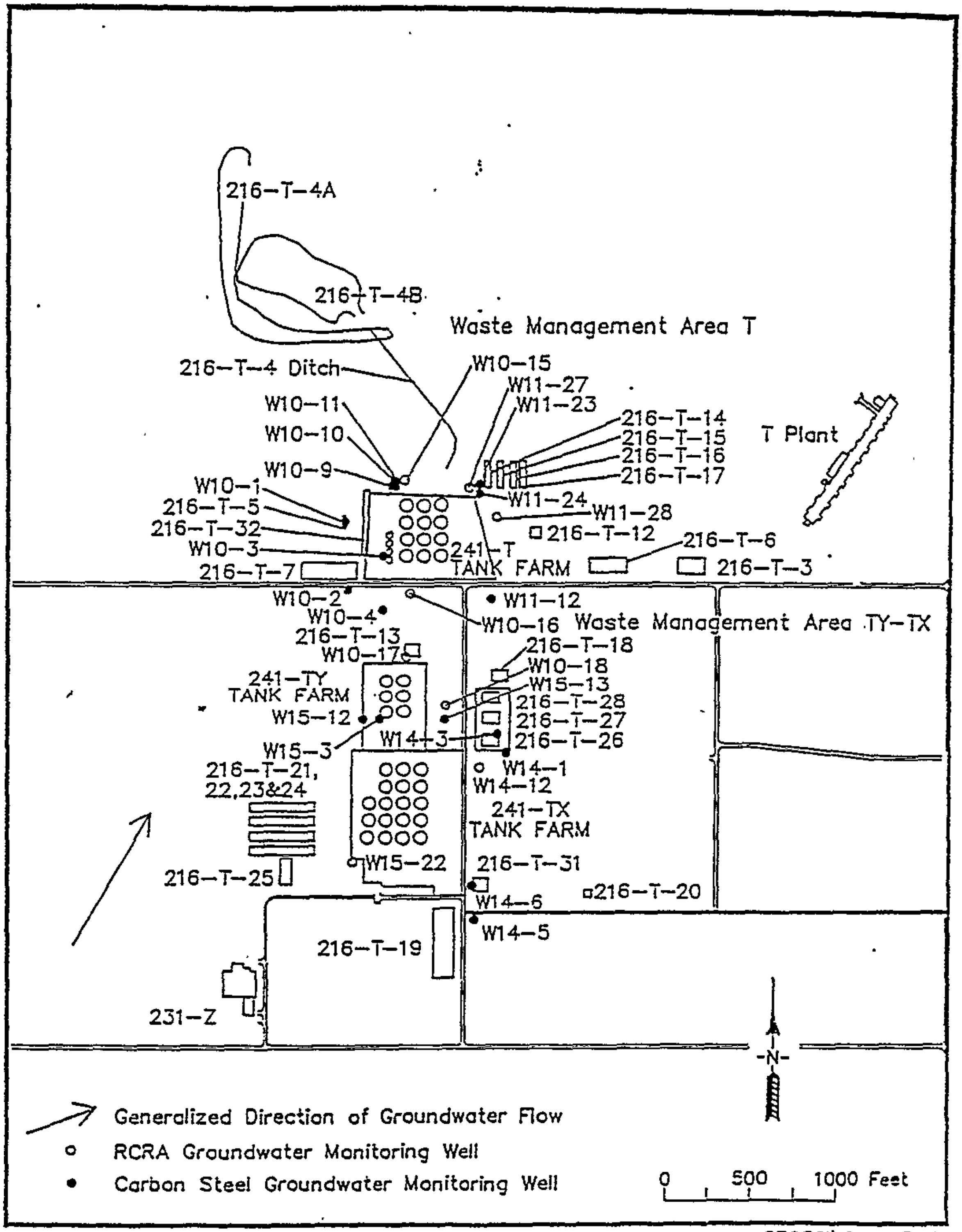
Figure 3. WMA T and TX-TY Showing Groundwater Monitoring Wells and Nearby Liquid Effluent Facilities.



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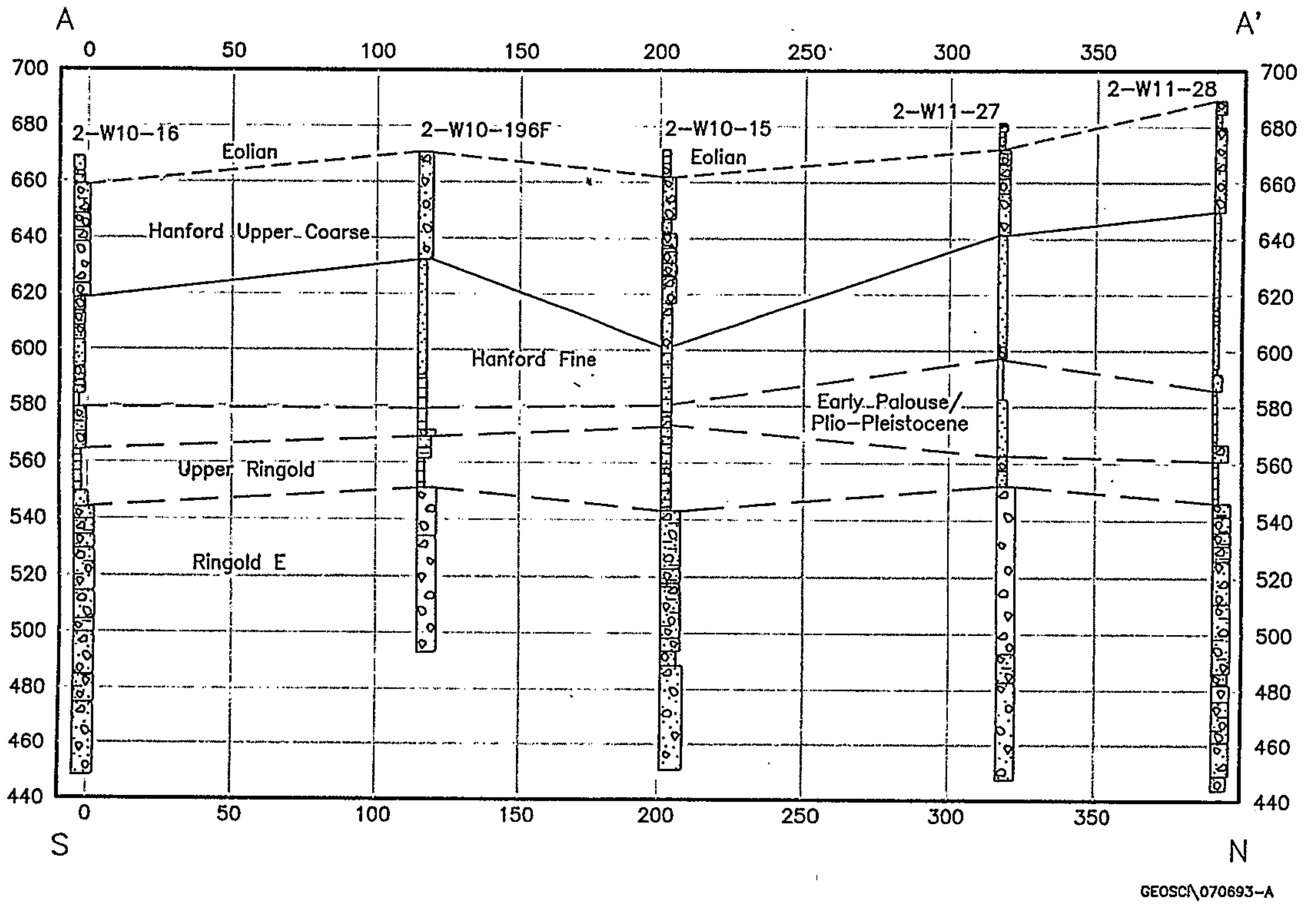

Figure 4. Geological Cross Section Beneath WMA T.

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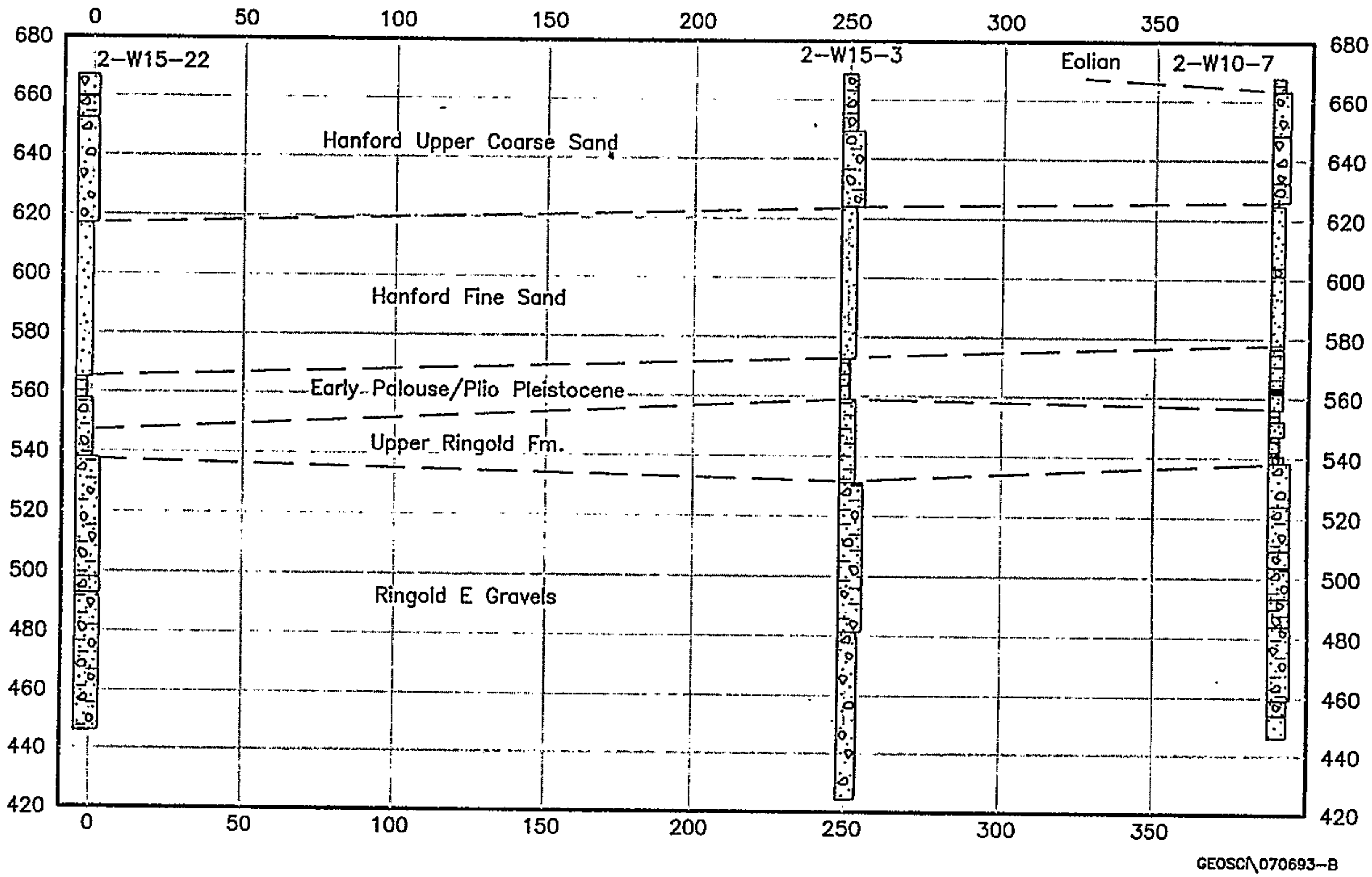


Figure 5. Geologic Cross Section Beneath WMA TX-TY.

Figure 6. SST WMA T Specific Conductance.

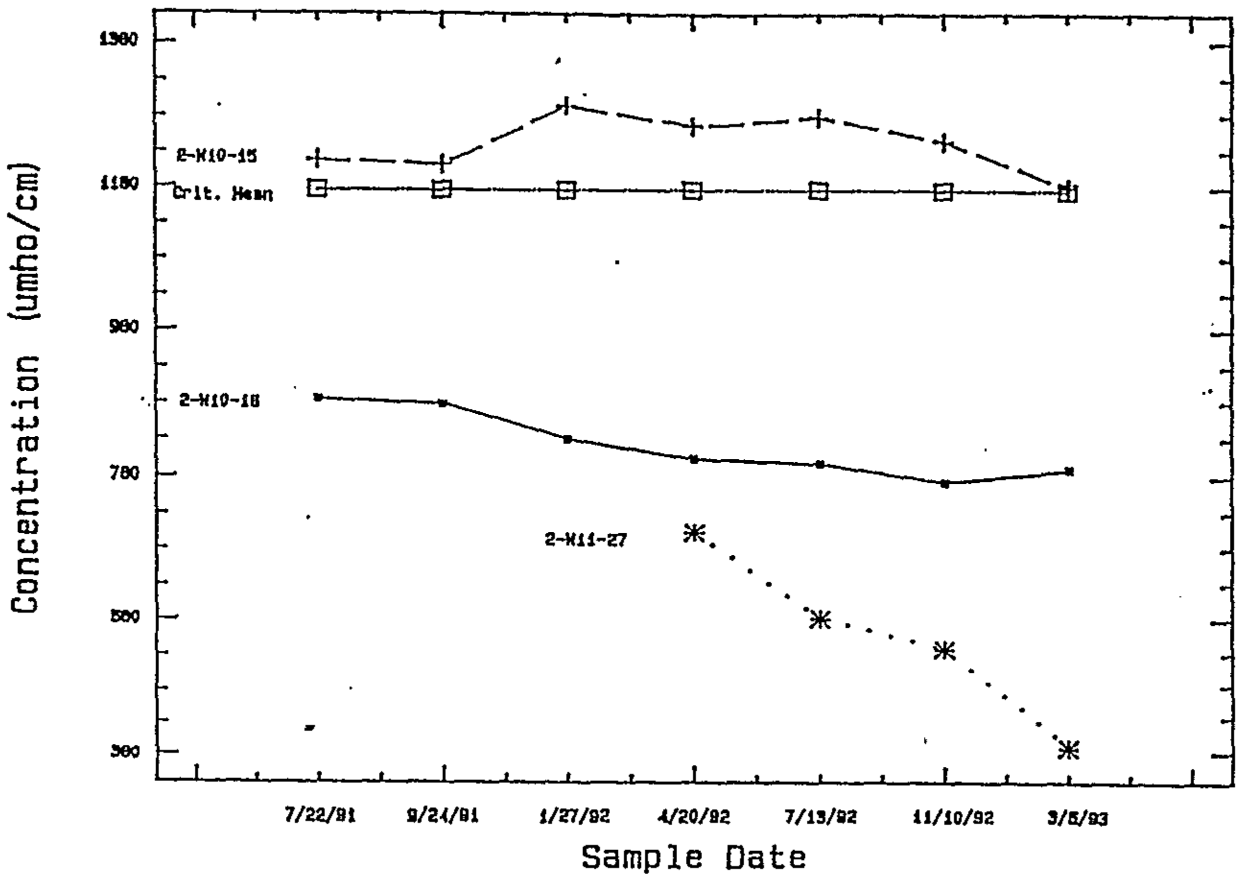


Figure 7. SST WMA TX-TY Specific Conductance.

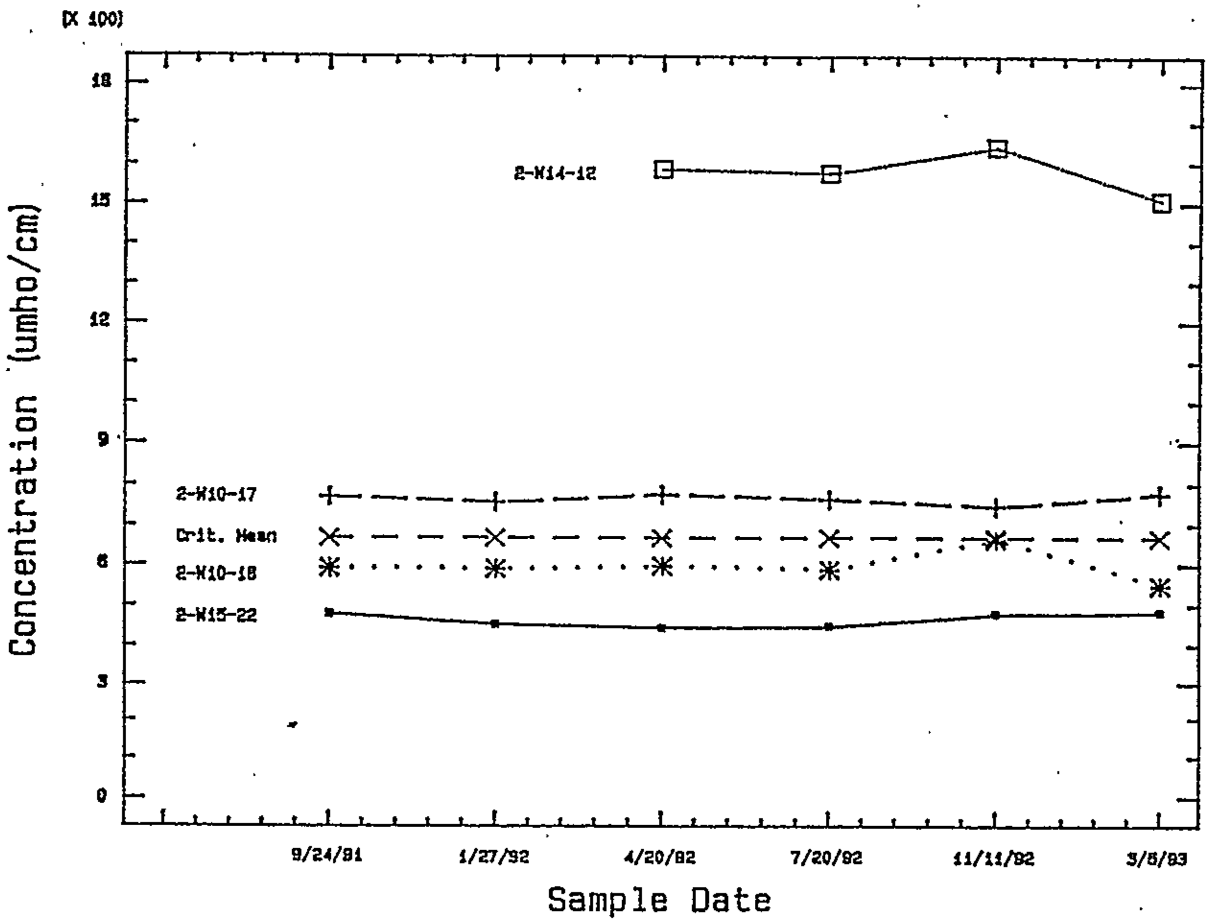


Table 2-1. Liquid Effluent Facilities in and Adjoining SST WMA T and TX-TY. (sheet 1 of 2)

Facility	Type	Dates of operation	Volume (gal)	Waste type	Radionuclides	Monitoring structures
216-T-4A	Pond	11/44-5/72	1,122,853,369#	221-T, 224-T Cooling water, stream condensate/cooling water; 2706-Tdecon. wastes	^{137}Cs, ^{106}Ru, ^{90}Sr	
216-T-4B	Pond	5/72-	????????	Steam condensate/cooling water from 242-T; 221-T non-rad, wastewater		
216-T-5	Trench	5/55-5/55	686,922	221-T 2nd cycle supernatant	^{137}Cs, ^{106}Ru, ^{90}Sr	299-W10-01
216-T-6	Crib	8/46-6/51	11,889,035	Cell drainage from Tank 5-6, 221-T; overflow waste from 241-T-316 tank from 224-T	^{137}Cs, ^{106}Ru, ^{90}Sr	
216-T-7	Crib & Tile Field	4/48-11/55	29,062,000	221-T 2nd cycle supernate; 221-T cell drainage	^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, uranium	299-W10-2, 299-W10-4
216-T-12	Trench	11/54-11/54	1,321,004	Sludge from 207-T		
216-T-13	Trench	6/54-6/64	???????	Vehicle decon waste	Mixed	
216-T-14*	Trench	1/54-1/54	264,200	221-T 1st cycle supernatant via 241-SST	^{137}Cs, ^{90}Sr, ^{106}Ru, plutonium, uranium	299-W11-68
216-T-15*	Trench	1/54-2/54	264,200	s/a 216-T-14	s/a 216-T-14	299-W11-69
216-T-16*	Trench	2/54-2/54	264,200	s/a 216-T-14	s/a 216-T-14	
216-T-17*	Trench	2/54-6/54	207,398	s/a 216-T-14	s/a 216-T-14	
216-T-18	Crib	12/53-12/53	264,200	221-T 1st cycle scavenged TBP supernatant	^{137}Cs, ^{190}Sr, ^{106}Ru, plutonium, uranium	299-W11-11
216-T-19	Crib	9/51-7/80	120,211,000	242-T process & steam condensate, 221-T cell drainage	^{241}Am, H-3, ^{137}Cs, ^{90}Sr, ^{106}Ru, plutonium, uranium	299-W15-4
216-T-20	Trench	11/52-11/52	4,993	Contaminated HNO_3 from 241-TX-155	^{137}Cs, ^{106}Ru, ^{90}Sr, uranium	
216-T-21	Trench	6/54-8/54	121,532	221-T first cycle supernate via 241-TX tanks	^{137}Cs, ^{106}Ru, ^{90}Sr, uranium, plutonium	
216-T-22	Trench	6/54-8/54	404,227	s/a 216-T-21	s/a 216-T-21	
216-T-23	Trench	7/54-8/54	391,017	s/a 216-T-21	s/a 216-T-21	

Table 2-1. Liquid Effluent Facilities in and Adjoining SST WMA T and TX-TY. (sheet 2 of 2)

Facility	Type	Dates of operation	Volume (gal)	Waste type	Radionuclides	Monitoring structures
216-T-24	Trench	8/54-8/54	404,227	s/a 216-T-21	s/a 216-T-21	
216-T-25	Trench	9/54-9/54	792,602	242-T first cycle evaporator bottoms via 241-TY tanks	s/a 216-T-21	
216-T-26	Crib	9/51-7/80	3,170,410	221-T first cycle supernatant via 241-TY tanks	^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, uranium	
216-T-27	Crib	9/65-11/65	1,899,600	340 Building Lab waste	^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, uranium	
216-T-28	Crib	2/60-2/66	11,175,700	221-T and 2706-T steam condensate decon; 340 building lab waste	^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, uranium	299-W14-2, 299-W14-3, 299-W14-4, 299-W14-11, 299-W11-11
216-T-31	French Drain	10/54-2/62	????????	Site cleaned in 1959 and released in 1962. No other info found		
216-T-32	Crib	11/46-5/52	7,661,823	224-T via T-201 tank	^{137}Cs, ^{90}Sr, ^{106}Ru, plutonium, uranium	299-W10-56, 57, 58, 64, 73, 75, 76
216-T-36	Crib	5/67-2/69	137,913	221-T and 221-U steam condensate decon. and misc. waste	^{137}Cs, ^{90}Sr, ^{106}Ru, plutonium, uranium	299-W10-2, W10-4
216-Z-7	Crib	2/57-2/67	21,109,600	231-Z process & lab waste via sump; 340 building lab waste	^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, uranium	299-W15-7
200 West Powerhouse Pond	Pond	8/64-	653,950,000+	Steam production/water treatment effluent	None known	
Total			1,988,510,000			

NOTES: These are known liquid effluent facilities and volumes known to have been discharged based on WIDS. Unplanned releases of waste and other liquids have likely gone to the ground during the history of Hanford operations and these contribute to the inventory wastes in the soils and groundwater as well as to the mobility of previously discharged wastes.

* The 216-T-14, -15, -16 and -17 facilities were specific retention trenches that received waste from the uranium scavenging process conducted in the mid 1950's to recover uranium from wastes previously discharged to SST

\+ Based on estimated 6.28-m gals liquid discharge/month from August 1984 to May 1993 Nitrate, ammonium nitrate, sulfate, fluoride, phosphate and sodium are among the key dangerous wastes discharged to these various cribs, ditches and ponds. Some received ferrocyanide. High salt wastes were discharged to some facilities.

\# May be the combined total of liquid effluent discharged to the 216-T-4A and 216-T-4B ponds.

Table 2-2. Unplanned Releases Associated with SST WMA T and TX-TY*.

Release number	Date	Comments
UPR-200-W-5	1950	Leaky jumpers/overflow around 241-TX-155 Diversion Box
UPR-200-W-28	1954	s/a
UPR-200-W-126	1975	Release during repair of 241-TX-153
UPR-200-W-129	1971	Release during testing of jumper at 241-TX-113 tank
UPR-200-W-131	1953	s/a UPR-200-W-5
UPR-200-W-147	1973	Contamination encountered during drilling well; likely from failed seal around spare entry line around 241-T-103 tank
UPR-200-W-148	1973	115,000-gal leak (largest known at any SST) likely started during filling of 241-T-106 tank
UPR-200-W-149	1977	High counts in gross gamma log of dry well; suspected leak from 241-TX-107 tank
UPR-200-W-150	1973	Overflow from 241-TX-155 Diversion Box back into 241-TY-103 tank
UPR-200-W-151	1974	Approx. 1,400-gal leak of supernatant from 241-TY-104 tank
UPR-200-W-152	1960	Confirmed 241-TY-105 as leaker: unknown quantity of TBP waste
UPR-200-W-153	1959	Confirmed 241-TY-106 as leaker; unknown quantity of TBP waste
UPR-200-W-7	1950	Soil contaminated during work around 241-T-151 and -152 Diversion Boxes
UPR-200-W-14	1952	Contaminated water rose to ground surface above waste line
UN-200-W-17	1952	Spill during transfer of pump from 241-TX-106 to 241-TX-114 tank
UN-200-W-29	1954	Unencased line connecting 241-T-152 and 241-TX-153 Diversion Boxes failed; released first cycle supernatant from 241-T-105 tank
UN-200-W-62	1966	Line rupture during transfer of waste from 241-T-107 tank to 242-T-Evaporator Feed
UN-200-W-63	1966	Release from Diversion Box jumper being moved via truck
UN-200-W-64	1969	Contamination discovered, possibly by runoff of snowmelt from adjoining contaminated area
UN-200-W-76	1977	Discovery of contaminated rabbit feces around 241-TX-155 Diversion Box
UN-200-W-97	1966	Waste solution leaked from broken underground line
UN-200-W-99	1968	Airborne release from 241-TY-153 Diversion Box
UN-200-W-100	1954	Waste spilled from line connecting 241-TX-105 and 241-TX-118 tanks
UN-200-W-113	1950's	Discovered contaminated rabbit feces and subsequently leaky transfer line around 241-TX-155 Diversion Box
UN-200-W-135	1954	Leak of approx. 1,000 gal supernatant north of 241-TX-155 Diversion Box

*Compiled from WIDS and DOE (1992)

Table 4-2a. Background Contamination Indicator Parameter Data for the SST WMA TX-TY. (sheet 1 of 3)

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700W	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W15-22	09/24/91	1	478	7.47	1000U	1400A
		2	478	7.46	1000U	885HA
		3	478	7.45	1000U	1400A
		4	478	7.46	1000U	1300HA
2-W15-22	10/16/91	1	501	7.51		
		2				
		3				
		4				
2-W15-22	01/27/92	1	456	8.30	1000U	320DA
		2	450	8.32	1000U	410DA
		3	451	8.31	1000U	740DA
		4	449	8.32	1000U	730DA
2-W15-22	04/20/92	1	446	7.67	1000UD	590A
		2	442	7.61	1000UD	510A
		3	442	7.60	1000UD	660A
		4	441	7.61	1000UD	390A
2-W15-22	07/20/92	1	449	7.75	1000U	830DA
		2	447	7.74	1000U	740DA
		3	448	7.72	1000U	750DA
		4	444	7.73	1000U	670DA
2-W10-17	10/09/91	1	762	7.88	1000U	830A
		2	770	7.87	1000U	730A
		3	772	7.88	1000U	1300A
		4	772	7.87	1000U	1100A
2-W10-17	10/15/91	1	772	7.99		
		2				
		3				
		4				
2-W10-17	11/25/91	1	788	7.91		
		2				
		3				
		4				

Table 4-2a. Background Contamination Indicator Parameter Data for the SST WMA TX-TY. (sheet 2 of 3)

Well name	Sample date	Dupl. sample no.	Specific Conductance µmho/cm 1/700w	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W10-17	01/22/92	1	756	8.08	1000^{U}	740^{A}
		2	759	8.09	1000^{U}	730^{A}
		3	753	8.07	1000^{U}	1100^{A}
		4	755	8.08	1000^{U}	990^{A}
2-W10-17	04/21/92	1	777	7.99	1000^{UD}	950^{A}
		2	775	8.01	1000^{UD}	1400^{A}
		3	772	7.99	1000^{UD}	3200^{A}
		4	774	8.00	1000^{UD}	1200^{A}
2-W10-17	07/20/92	1	766	7.93	1000^{U}	550^{A}
		2	760	7.93	1000^{U}	780^{A}
		3	759	7.92	1000^{U}	490^{A}
		4	761	7.93	1000^{U}	480^{A}
2-W10-18	09/24/91	1	590	7.64	1000^{U}	755^{HA}
		2	591	7.64	1000^{U}	760^{HA}
		3	591	7.64	1000^{U}	835^{HA}
		4	591	7.63	1000^{U}	875^{HA}
2-W10-18	10/15/91	1	607	7.84		
		2				
		3				
		4				
2-W10-18	03/11/92	1	594	7.82	1000^{U}	520^{DA}
		2	588	7.81	1000^{U}	620^{DA}
		3	585	7.82	1000^{U}	470^{DA}
		4	588	7.83	1000^{U}	610^{DA}
2-W10-18	04/20/92	1	594	7.71	1000^{UD}	500^{A}
		2	595	7.72	1000^{UD}	590^{A}
		3	598	7.69	1000^{UD}	760^{A}
		4	597	7.69	1000^{UD}	530^{A}
2-W10-18	07/21/92	1	592	8.22	1000^{U}	70^{DA}
		2	588	8.22	1000^{U}	320^{DA}
		3	576	8.22	1000^{U}	560^{DA}
		4	591	8.21	1000^{U}	590^{DA}

Table 4-2a. Background Contamination Indicator Parameter Data for the SST WMA TX-TY. (sheet 3 of 3)

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700w	Field pH o.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W14-12	04/21/92	1	1574	7.53	1000^UD	350^DA
		2	1581	7.55	1000^UD	240^DHA
		3	1586	7.54	1000^UD	560^DHA
		4	1595	7.55	1000^UD	380^DHA
2-W14-12	07/20/92	1	1591	7.64	1000^U	250^DA
		2	1564	7.63	1000^U	160^DA
		3	1589	7.63	1000^U	230^DA
		4	1547	7.63	1000^U	140^DA

The column headers consist of: Constituent Name; Analysis Units; and Contractual Required Quantitation Limit/Drinking Water Standard (suffix)

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

U denotes that analyte concentration is below CRQL. Reported values were analytical laboratories' CRQL.

H denotes that holding time was exceeded.

A denotes unsatisfactory audit findings (DOE 1993a).

D denotes that Nonconformance report was issued by the analytical laboratory.

Table 4-2b. Background Contamination Indicator Parameter Data for the SST WMA T. (page 1 of 2)

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700u	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W10-16	07/22/91	1	880	8.01	1000^{U}	270^{HA}
		2	880	8.00	1000^{U}	520^{HA}
		3	888	8.00	1000^{U}	500^{HA}
		4	885	7.99	1000^{U}	600^{HA}
2-W10-16	09/24/91	1	880	7.33	1000^{U}	655^{A}
		2	876	7.33	1000^{U}	650^{A}
		3	877	7.34	1000^{U}	540^{A}
		4	873	7.36	1000^{U}	625^{HA}
2-W10-16	10/15/91	1	858	7.52		
		2				
		3				
		4				
2-W10-16	11/25/91	1	828	7.93		
		2				
		3				
		4				
2-W10-16	01/27/92	1	830	7.75	1000^{U}	560^{DA}
		2	830	7.77	1000^{U}	1100^{DA}
		3	823	7.78	1000^{U}	710^{DA}
		4	826	7.78	1000^{U}	660^{DA}
2-W10-16	04/20/92	1	811	7.64	1000^{UD}	920^{A}
		2	802	7.66	1000^{UD}	950^{A}
		3	795	7.66	1000^{UD}	1100^{A}
		4	801	7.67	1000^{UD}	770^{A}
2-W10-16	07/13/92	1	796	7.77	1000^{U}	620^{DA}
		2	796	7.76	1000^{U}	650^{DA}
		3	796	7.76	1000^{U}	560^{DA}
		4	795	7.76	1000^{U}	210^{DA}
2-W10-15	07/22/91	1	1217	7.80	1000^{U}	470^{HA}
		2	1215	7.77	1000^{U}	890^{HA}
		3	1225	7.76	1000^{U}	980^{HA}
		4	1212	7.75	1000^{U}	930^{HA}

Table 4-2b. Background Contamination Indicator Parameter Data for the SST WMA T. (sheet 2 of 2)

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700w	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W10-15	10/04/91	1	1214	8.00	1000^{U}	580^{HA}
		2	1214	7.95	1000^{U}	725^{HA}
		3	1208	7.94	1000^{U}	550^{HA}
		4	1207	7.93	1000^{U}	515^{HA}
2-W10-15	01/27/92	1	1299	8.21	1000^{U}	510^{DA}
		2	1291	8.22	1000^{U}	370^{DA}
		3	1292	8.23	1000^{U}	610^{DA}
		4	1293	8.23	1000^{U}	200^{DA}
2-W10-15	04/20/92	1	1262	8.01	1000^{UD}	1600^{A}
		2	1263	7.98	1000^{UD}	940^{A}
		3	1266	8.04	1000^{UD}	920^{A}
		4	1269	8.03	1000^{UD}	920^{A}
2-W10-15	07/13/92	1	1274	7.85	1000^{U}	830^{DA}
		2	1278	7.84	1000^{U}	1100^{DA}
		3	1280	7.85	1000^{U}	600^{DA}
		4	1282	7.84	1000^{U}	600^{DA}
2-W11-27	05/27/92	1	705	8.00	1000^{U}	20^{A}
		2	701	8.00	1000^{U}	10^{A}
		3	701	8.00	1000^{U}	20^{A}
		4	701	8.00	1000^{U}	10^{UA}
2-W11-27	07/13/92	1	580	7.88	1000^{U}	260^{DA}
		2	578	7.89	1000^{U}	10^{UA}
		3	582	7.89	1000^{U}	10^{UA}
		4	587	7.89	1000^{U}	10^{UA}
2-W11-28	05/27/92	1	1113	7.76	1000^{U}	220^{DA}
		2	1098	7.76	1000^{U}	270^{DA}
		3	1086	7.75	1000^{U}	270^{DA}
		4	1093	7.75	1000^{U}	250^{DA}

Column headers consist of: Analysis Units; and Contractual Required Quantitation Limit/Drinking Water Standard (suffix)

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR part 143, National Secondary Drinking Water Regulations

w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:

- U denotes analyte concentration is below CRQL. Reported values were analytical laboratories' CRQL.
- H denotes that holding time was exceeded.
- A denotes unsatisfactory audit findings (DOE 1993a).
- D denotes that Nonconformance report was issued by the analytical laboratory.

Table 4-3a. Average Replicate Statistics--Background Indicator Parameter Data for the SST WMA TX-TY.

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	CV (%)
Specific conductance (μmho/cm)	2-W15-22	09/24/91	4	478.00	0	0
	2-W15-22	01/27/92	4	451.50	3.109	0.69
	2-W15-22	04/20/92	4	442.75	2.217	0.50
	2-W15-22	07/20/92	4	447.00	2.160	0.48
Field pH	2-W15-22	09/24/91	4	7.460	0.008	0.11
	2-W15-22	01/27/92	4	8.312	0.010	0.12
	2-W15-22	04/20/92	4	7.622	0.032	0.42
	2-W15-22	07/20/92	4	7.735	0.013	0.17
TOC[a] (ppb)	2-W15-22	09/24/91	4	500[U]	NA	N.A.
	2-W15-22	01/27/92	4	500[U]	NA	N.A.
	2-W15-22	04/20/92[D]	4	NC	NA	N.A.
	2-W15-22	07/20/92	4	500[U]	NA	N.A.
TOX[a] (ppb)	2-W15-22	09/24/91	4	1246.25	245.404	19.69
	2-W15-22	01/27/92[DA]	4	NC	NC	N.C.
	2-W15-22	04/20/92[A]	4	NC	NC	N.C.
	2-W15-22	07/20/92[DA]	4	NC	NC	N.C.

Note: Summary statistics calculated from only those samples that had four replicate values.

[a]statistics were calculated by replacing not detected values with half of the respective CRQL.

[U]denotes calculated values are below the CRQL.

[D]statistics were not calculated due to nonconformance Report.

[A]replicate averages are not calculated due to audit findings (DOE 1993a).

NA = not available. CV = coefficient of variation.
NC = not calculated.

Table 4-3b. Average Replicate Statistics--Background Indicator Parameter Data for the SST WMA T.

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	CV (%)
Specific conductance (μmho/cm)	2-W10-16	07/22/91	4	883.25	3.948	0.45
	2-W10-16	09/24/91	4	876.50	2.887	0.33
	2-W10-16	01/27/92	4	827.25	3.403	0.41
	2-W10-16	04/20/92	4	802.25	6.602	0.82
	2-W10-16	07/13/92	4	795.75	0.500	0.06
Field pH	2-W10-16	07/22/91	4	8.000	0.008	0.10
	2-W10-16	09/24/91	4	7.340	0.014	0.19
	2-W10-16	01/27/92	4	7.770	0.014	0.18
	2-W10-16	04/20/92	4	7.658	0.013	0.16
	2-W10-16	07/13/92	4	7.762	0.005	0.06
TOC[a] (ppb)	2-W10-16	07/22/91	4	500[U]	NA	NA
	2-W10-16	09/24/91	4	500[U]	NA	NA
	2-W10-16	01/27/92	4	500[U]	NA	NA
	2-W10-16	04/20/92[D]	4	NC	NA	NA
	2-W10-16	07/13/92	4	500[U]	NA	NA
TOX (ppb)	2-W10-16	07/22/91	4	472.50	141.745	30.00
	2-W10-16	09/24/91	4	617.50	53.307	8.63
	2-W10-16	01/27/92[DA]	4	NC	NC	NC
	2-W10-16	04/20/92[A]	3	NC	NC	NC
	2-W10-16	07/13/92[DA]	4	NC	NC	NC

Note: Summary statistics calculated from only those samples that had four replicate values.
[a]statistics were calculated by replacing not detected values with half of the respective CRQL.
[U]denotes calculated values are below the CRQL.
[D]statistics were not calculated due to Non-Conformance Report.
[A]replicate averages are not calculated due to audit findings (DOE 1993a).
NA = not available. CV = coefficient of variation.
NC = not calculated.

Table 4-4a. Background Statistics[a]--Contamination Indicator Parameter Data for the SST WMA TX-TY.

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	μmhos/cm	4	454.812	15.866	3.49
Field pH		4	7.782	0.371	4.77
TOC	ppb	3	500	NA	NA
TOX[b]	ppb	NC	NC	NC	NC

Note: Summary statistics calculated from only those samples that had replicate values.

[a]Background summary statistics for TOC were calculated using values below CRQL.
[b]Background summary statistics for TOX are not calculated due to audit findings of DataChem Laboratories (DOE 1993a).

NA = not available.
NC = not calculated.

9413151.2067

Table 4-4b. Background Statistics[a]--Contamination Indicator Parameter Data for the SST WMA T.

Constituent	Units	n	Background average	Background standard deviation	Background C.V. (%)
Specific conductance	μmhos/cm	5	837	40.938	4.89
Field pH		5	7.706	0.240	3.11
TOC	ppb	4	500	NA	NA
TOX[b]	ppb	NC	NC	NC	NC

Note: Summary statistics calculated from only those samples that had replicate values.

[a]Background summary statistics for TOC were calculated using values below CRQL.
[b]Background summary statistics for TOX are not calculated due to audit findings of DataChem Laboratories (DOE 1993a).

NA = not available.
NC = not calculated.

Table 4-5a. Critical Means Table for 16 Comparisons--Background Contamination Indicator Parameter Data for the SST WMA TX-TY[a,b].

Constituent (unit)	n	df	tc	Average background	Standard deviation	Critical mean
Specific conductance (μmho/cm)	4	3	11.984	454.812	15.866	667.4
Field pH	4	3	15.145	7.782	0.371	[1.5, 14.0]
TOC[c] (ppb)	3[e]	2	28.258	500	NA	1,400[c]
TOX[d] (ppb)	NC	NC	NC	NC	NC	NC

[a]Data collected from September 1991 to July 1992 for upgradient well 2-W15-22. Values calculated based on 16 comparisons.
[b]The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 16 comparisons.
NC = not calculated.
[c]Critical mean cannot be calculated due to lack of an estimate of background standard deviation. The limit of quantitation (based on field blanks data) is used as the TOC critical mean (DOE 1993b).
[d]Critical mean is not calculated due to audit findings (DOE 1993a).
[e]Excluding TOC values collected on 4/20/92 from well 2-W15-22 because of Nonconformance Report.

Table 4-5b. Critical Means Table for 12 Comparisons--Background Contamination Indicator Parameter Data for the SST WMA T[a,b].

Constituent (unit)	n	df	tc	Average background	Standard deviation	Critical mean
Specific conductance (μmho/cm)	5	4	7.5288	837	40.938	1174.6
Field pH	5	4	9.0288	7.706	0.240	[5.33, 10.08]
TOC[c] (ppb)	4[e]	3	10.869	500	NA	1,400[c]
TOX[d] (ppb)	NC	NC	NC	NC	NC	NC

[a]Data collected from July 1991 to July 1992 for upgradient well 2-W10-16. Values calculated based on 12 comparisons.
[b]The following notations are used in this table:
df = degrees of freedom (n-1).
n = number of background replicate averages.
t_c = Bonferroni critical t-value for appropriate df and 12 comparisons.
NC = not calculated.
[c]Critical mean cannot be calculated due to lack of an estimate of background standard deviation. The limit of quantitation (based on field blanks data) is used as the TOC critical mean (DOE 1993b).
[d]Critical mean is not calculated due to audit findings (DOE 1993a).
[e]Excluding TOC values collected on 4/20/92 from well 2-W10-16 because of nonconformance Report.

Table 4-6a. November 1992 Contamination Indicator Parameter Data for the SST WMA TX-TY.

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700w	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W15-22	11/11/92	1	480	7.98	1000^U	910^A
		2	479	7.99	1000^U	700^A
		3	477	7.98	1000^U	790^A
		4	476	7.99	1000^U	850^A
2-W10-17	11/11/92	1	743	8.02	1000^U	740^A
		2	743	8.10	1000^U	1100^A
		3	746	8.11	1000^U	820^A
		4	747	8.12	1000^U	890^A
2-W10-18	11/13/92	1	708	6.45^R	1000^U	560^A
		2	647	7.08^R	1000^U	650^A
		3	645	7.10^R	1000^U	650^A
		4	647	7.14^R	1000^U	460^A
2-W14-12	11/11/92	1	1661	7.70	1000^U	150^A
		2	1648	7.72	1000^U	320^A
		3	1631	7.73	1000^U	260^A
		4	1616	7.74	1000^U	250^A

The column headers consist of: Constituent Name; Analysis Units; and Contractual Required Quantitation Limit/Drinking Water Standard (suffix)

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:
U = denotes that analyte concentration is below CRQL. Reported values were analytical laboratories' CRQL.
A = denotes unsatisfactory audit findings (DOE 1993a).
R = denotes suspect data currently under review.
NA = not available.

Table 4-6b. November 1992 Contamination Indicator Parameter Data for the SST WMA T.

Well name	Sample date	Dupl. sample no.	Specific conductance µmho/cm 1/700w	Field pH 0.01/8.5s	TOC ppb 1000/.	TOX ppb 10/.
2-W10-16	11/10/92	1	777	7.76	1000[U]	850[A]
		2	773	7.78	1000[U]	670[A]
		3	769	7.80	1000[U]	750[A]
		4	769	7.81	1000[U]	620[A]
2-W10-15	11/10/92	1	1249	8.15	1000[U]	630[A]
		2	1245	8.15	1000[U]	750[A]
		3	1242	8.16	1000[U]	780[A]
		4	1239	8.15	1000[U]	610[A]
2-W11-27	11/10/92	1	540	8.08	1000[U]	10[UA]
		2	538	8.09	1000[U]	10[UA]
		3	535	8.09	1000[U]	10[UA]
		4	537	8.08	1000[U]	10[UA]

The column headers consist of: Constituent Name; Analysis Units; and Contractual Required Quantitation Limit/Drinking Water Standard (suffix)

Suffix s = based on Secondary Maximum Contaminant Levels in 40 CFR part 143, National Secondary Drinking Water Regulations
w = based on additional Secondary Maximum Contaminant Levels in WAC 248-54, Public Water Supplies

Data flag:
u = denotes that analyte concentration is below CRQL. Reported values were analytical laboratories' CRQL.
A = denotes unsatisfactory audit findings (DOE 1993a).
NA = not available

Table 4-7a. November 1992 Contamination Indicator Parameter Replicate Averages for the SST WMA TX-TY.

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance (μmho/cm	2-W15-22	11/11/92	4	478.00	1.826	0.38
	2-W10-17	11/11/92	4	744.75	2.062	0.28
	2-W10-18	11/13/92	4	661.75	30.848	4.66
	2-W14-12	11/11/92	4	1639.00	19.647	1.20
Field pH	2-W15-22	11/11/92	4	7.985	0.006	0.07
	2-W10-17	11/11/92	4	8.105	0.013	0.16
	2-W10-18	11/13/92*	4	6.942	0.329	4.74
	2-W14-12	11/11/92	4	7.722	0.017	0.22
TOC[a] (ppb)	2-W15-22	11/11/92	4	500[u]	NA	NA
	2-W10-17	11/11/92	4	500[u]	NA	NA
	2-W10-18	11/13/92	4	500[u]	NA	NA
	2-W14-12	11/11/92	4	500[u]	NA	NA
TOX[a] (ppb)	2-W15-22	11/11/92	4	NC	NC	NC
	2-W10-17	11/11/92	4	NC	NC	NC
	2-W10-18	11/13/92	4	NC	NC	NC
	2-W14-12	11/11/92	4	NC	NC	NC

Note: Summary statistics calculated from only those samples that had four replicate values.

[a]Statistics were calculated by replacing not detected values with half of the respective CRQL.
[u]denotes calculated values are below the CRQL.
[a]replicate averages are not calculated due to audit findings (DOE 1993a).
*replicate average is inconsistent with historical trend (data is currently under review).

NA = not available.
NC = not calculated.
CV = coefficient of variation.

Table 4-7b. November 1992 Contamination Indicator Parameter Replicate Averages for SST WMA T.

Constituent (unit)	Well name	Sample date	n	Average	Standard deviation	C.V. (%)
Specific conductance µmho/cm	2-W10-16	11/10/92	4	772.00	3.830	0.50
	2-W10-15	11/10/92	4	1243.75	4.272	0.34
	2-W11-27	11/10/92	4	537.50	2.082	0.39
Field pH	2-W10-16	11/10/92	4	7.788	0.022	0.28
	2-W10-15	11/10/92	4	8.152	0.005	0.06
	2-W11-27	11/10-92	4	8.085	0.006	0.07
TOC[a] (ppb)	2-W10-16	11/10/92	4	500[u]	NA	NA
	2-W10-15	11/10/92	4	500[u]	NA	NA
	2-W11-27	11/10/92	4	500[u]	NA	NA
TOX[a] (ppb)	2-W10-16	11/10/92	4	NC	NC	NC
	2-W10-15	11/10/92	4	NC	NC	NC
	2-W11-27	11/10/92	4	NC	NC	NC

Note: Summary statistics calculated from only those samples that had four replicate values.

[a]statistics were calculated by replacing not detected values with half of the respective CRQL.
[u]denotes calculated values are below the CRQL.
[a]replicate averages are not calculated due to audit findings (DOE 1993a).

NA = not available.
NC = not calculated.
CV = coefficient of variation.

Table 4-8a. Contamination Verification Sampling Results for the SST WMA TX-TY.

Well name	Sample date	Replicate sample number	Specific conuctance #1	Specific conductance #2
2-W10-17	4/29/93	1	752	749
		2	754	751
		3	754	750
		4	752	750
2-W14-12	04/29/93	1	1,784	1,743
		2	1,782	1,746
		3	1,785	1,744
		4	1,825	1,744

Table 4-8b. Contamination Verification Sampling Results for the SST WMA T.

Well name	Sample date	Replicate sample number	Specific conuctance #1	Specific conductance #2
2-W10-15	4/29/93	1	1,162	1,142
		2	1,162	1,146
		3	1,162	1,163
		4	1,136	1,167
2-W10-15	03/05/93	1	1,173	
		2	1,179	
		3	1,185	
		4	1,183	

APPENDIX A

AS-BUILT DIAGRAMS OF GROUNDWATER MONITORING WELLS

9413151.2075

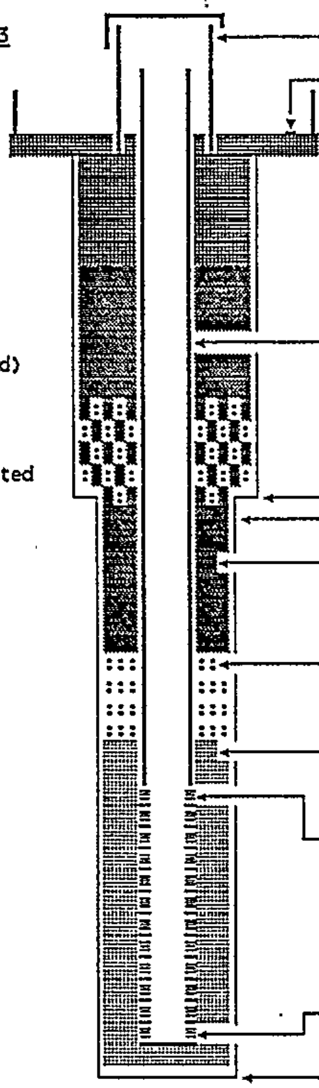
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W10-15 TEMPORARY WELL NO: None
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 43,790.7 E/W W 75,857.5
Driller's Name: C. Walmsley	WA State Lic Nr: Not documented	State NAD83 N 136,808.33m E 566,770.69m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 448,898 E 2,219,355
Date Started: 20Sep89	Date Complete: 07Nov89	Start Card #: Not documented T____ R____ S______
		Elevation Ground surface (ft): 672.45 (Brass cap)

Depth to water: 206.2-ft Nov89
(Ground surface) 210.6-ft 26Mar93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0↔10: Muddy SAND
10↔15: Sl gravelly sl muddy SAND
15↔25: Sandy GRAVEL
25↔30: SAND with MUD layers
35↔40: Sandy GRAVEL
40↔45: GRAVEL
45↔50: Muddy sandy GRAVEL
50↔60: Sandy GRAVEL
60↔73: Gravelly SAND
73↔75: Muddy fine SAND (laminated)
75↔80: Gravelly SAND
80↔93: Muddy SAND (calcareous)
93↔94: CALICHE
94↔96: Muddy SAND
96↔132: CALICHE-calcareous cemented muddy SAND
132↔180: Muddy sandy GRAVEL
180↔185: Sandy GRAVEL
185↔190: Gravelly SAND
190↔222.3: Sandy GRAVEL



Elevation of reference point: (top of casing) [675.64-ft]
Height of reference point above ground surface [3.19-ft]
Depth of surface seal [2.0↔19.6-ft]
Type of surface seal: Pre-mix concrete 4x4-ft x 6-in surface pad to 2.4-ft
4 equidistant protective posts
Cement grout, 2.0↔19.6-ft

I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel

Diameter of borehole,
0↔140.0-ft, 11-in nominal
140.0↔222.3-ft, 9-in nominal

Type of filler, 19.6↔72.3 & 140.8↔193.3-ft
8↔20 mesh bentonite crumbles
72.3↔140.8-ft
Volclay Pure Gold slurry

Depth top of seal: [193.3-ft]
Type of seal:
5/8-in Volclay pellets

Depth top of sand pack: [197.1-ft]
20↔40-mesh silica sand

Depth top of screen: [201.0-ft]
4-in, #10-slot, stainless steel with channel pack

Depth bottom of screen [222.0-ft]

Depth to bottom of borehole: [222.3-ft]

Drawing By: RKL/2W10-15.ASB   Date: 16Apr93

Reference: WHC-MR-0209

9413154.2076

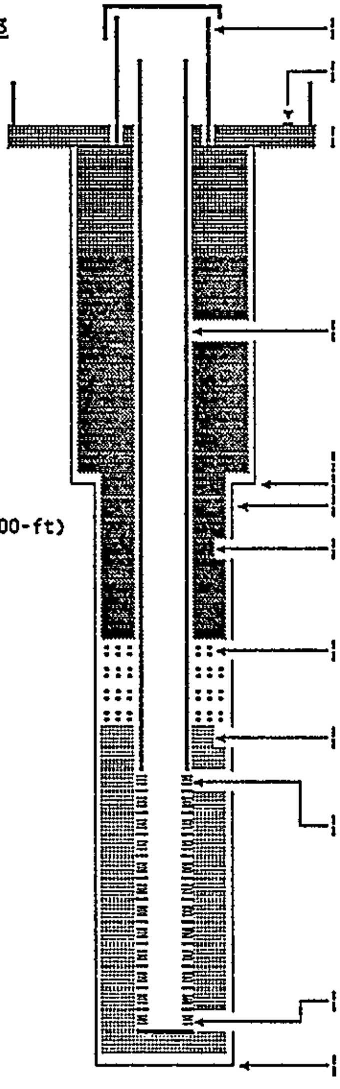
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W10-16 TEMPORARY WELL NO: None
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 43,129.6 E/W W 75,824.6
Driller's Name: D. Garcia/G. Lydin	WA State Lic Nr: Not documented	State NAD83 N 136,606.86m E 566,781.22m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 448,237 E 2,219,390
Date Started: 07Sep89	Date Complete: 25Oct89	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface (ft): 669.76 (Brass cap)

Depth to water: 202.9-ft Oct89
(Ground surface) 207.5-ft 26Mar93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0↔10: SAND
10↔15: Muddy SAND
15↔20: Muddy sandy GRAVEL
20↔25: GRAVEL
25↔30: Muddy sandy GRAVEL
30↔50: GRAVEL
50↔55: Muddy sandy GRAVEL
55↔60: Sl gravelly SAND
60↔65: Gravelly muddy SAND
65↔70: Sl gravelly SAND
70↔80: SAND
80↔85: Sl gravelly SAND
85↔90: Muddy SAND
90↔95: Sandy MUD (Buried soil?)
95↔100: Sl gravelly muddy SAND W/CALICHE
100↔110: Gravelly muddy SAND (15ppm VOC in spoils @ 100-ft)
110↔125: Sandy MUD
125↔130: Sl muddy SAND
130↔135: Sandy GRAVEL
135↔140: Muddy sandy GRAVEL
140↔145: Sandy GRAVEL
145↔160: Muddy sandy GRAVEL
160↔170: Sandy GRAVEL
170↔175: Muddy sandy GRAVEL
175↔190: Sandy GRAVEL
190↔200: Muddy sandy GRAVEL
200↔219.8: Sandy GRAVEL



Elevation of reference point: (top of casing) [672.76-ft]

Height of reference point above ground surface [3.0-ft]

Depth of surface seal [2.1↔18.1-ft]

Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad to 2.4-ft
4 equidistant protective posts
Cement grout, 2.1↔18.1-ft

I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel

Diameter of borehole,
0↔132.9-ft, 11-in nominal
132.9↔219.8-ft, 9-in nominal

Type of filler, 18.1↔191.4-ft
8↔20 mesh bentonite crumbles

Depth top of seal: [191.4-ft]
Type of seal:
3/8-in Volclay pellets

Depth top of sand pack: [195.4-ft]
20↔40-mesh silica sand

Depth top of screen: [198.3-ft]
4-in, #10-slot, stainless steel
with channel pack

Depth bottom of screen [219.3-ft]

Depth to bottom of borehole: [219.8-ft]

Drawing By: RKL/2W10-16.ASB Date: 16Apr93

Reference: WHC-MR-0209

9413514.2077

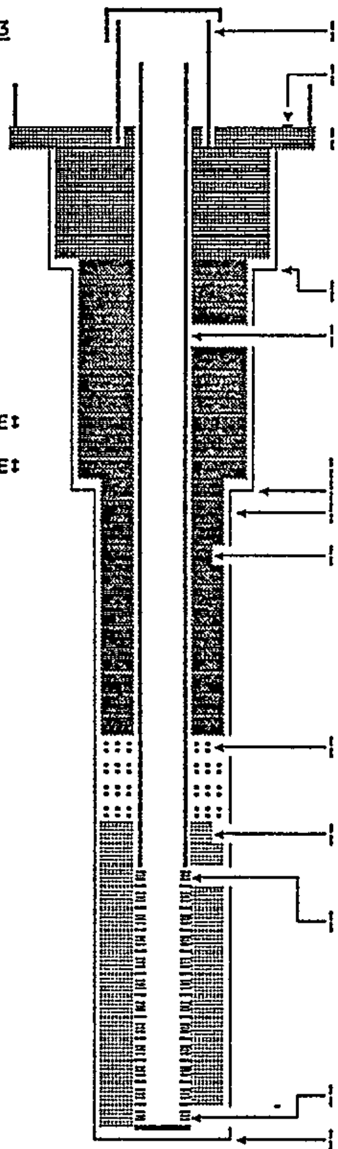
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W10-17 TEMPORARY WELL NO: None
Drilling Fluid Used: 200 W Water Supply	Additives Used: None	Hanford Coordinates: N/S N 42,751 E/W W 75,844
Driller's Name: D. Ludtke	WA State Lic Nr: Not documented	State NAD83 N 136,491.46m E 566,775.74m Coordinates: N 447,858 E 2,219,371
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 28Nov90	Date Complete: 17Jan91	Elevation Ground surface (ft): 667.91 Brass cap

Depth to water: 202.6-ft Dec90
(Ground surface) 205.3-ft 26Mar93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0↔5: (Backfill) Gravelly SAND
5↔10: Silty SAND
10↔15: Sandy GRAVEL
15↔20: Silty sandy GRAVEL
20↔35: GRAVEL
35↔42.5: Sandy GRAVEL
42.5↔43: SILT lens
43↔64: SAND
64↔67: Gravelly SAND
67↔90: SAND
90↔95: Sl silty SAND
95↔105: Silty SAND
‡Some interbedded CALICHE‡
105↔110: Gravelly silty SAND
‡Some interbedded CALICHE‡
110↔115: Sl silty SAND
115↔120: Sandy SILT
120↔125: SAND
125↔128: Sandy SILT
128↔130: Gravelly SAND
130↔135: GRAVEL
135↔210: Silty sandy GRAVEL
210↔215: Sl silty gravelly SAND
215↔222.9: SAND



Elevation of reference point: (top of casing) [670.84-ft]
Height of reference point above ground surface [2.93-ft]
Depth of surface seal [0↔20-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad to 2.9-ft
4 equidistant protective posts
Cement grout, 2.9↔20.0-ft
13-in nominal hole to 20.7-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
20.7↔129.7-ft, 11-in nominal
129.7↔222.9-ft, 9-in nominal
Type of filler, 20.0↔193.0-ft
8↔20 mesh bentonite crumbles
Depth top of seal: [193.0-ft]
Type of seal:
Bentonite pellets
Depth top of sand pack: [197.4-ft]
8↔12-mesh silica sand
Depth top of screen: [201.4-ft]
4-in, #10-slot, stainless steel
with channel pack
Depth bottom of screen [222.7-ft]
Depth to bottom of borehole: [222.9-ft]

Drawing By: RKL/2W10-17.ASB   Date: 16Apr93

Reference: WHC-SD-EN-DP-041

9413154.2078

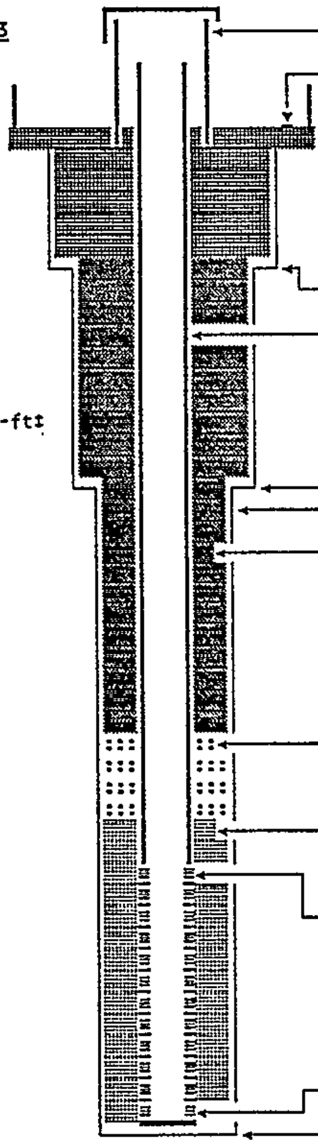
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W10-18 TEMPORARY WELL NO: None
Drilling Fluid Used: 200 W Water Supply	Additives Used: None	Hanford Coordinates: N/S N 42,439 E/W W 75,610
Driller's Name: G. Lydin/W. Peters	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 136,396.52m E 566,847.18m; N 447,547 E 2,219,606
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 01Nov90	Date Complete: 12Dec90	Elevation Ground surface (ft): 668.08 Brass cap

Depth to water: 202.2-ft Dec90
(Ground surface) 204.8-ft 26Mar93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔5: (Backfill)
5↔25: Silty sandy GRAVEL
25↔40: Sandy GRAVEL
40↔43: Silty sandy GRAVEL (BOULDER @ 42-ft)
43↔55: Sl gravelly SAND
55↔65: SAND
65↔80: Gravelly SAND
80↔90: Sl gravelly SAND
90↔91: SAND
91↔97: Sl silty SAND
97↔105: Silty sandy GRAVEL ±CALICHE, 97,101,111↔113-ft
105↔115: Gravelly silty SAND
115↔120: Gravelly SAND
120↔125: Gravelly silty SAND
125↔129: Silty SAND
129↔160: Silty sandy GRAVEL
160↔165: SAND
165↔175: Silty sandy GRAVEL
175↔190: Sandy GRAVEL
190↔200: Muddy sandy GRAVEL
200↔221.6: Silty sandy GRAVEL



Elevation of reference point: (top of casing) [670.93-ft]
Height of reference point above ground surface [2.85-ft]
Depth of surface seal [0↔18.6-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad to 2.0-ft
4 equidistant protective posts
Cement grout, 2.0↔18.6-ft
13-in nominal hole to 20.2-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole,
20.2↔146.9-ft, 11-in nominal
146.9↔222.6-ft, 9-in nominal
Type of filler, 20.0↔193.5-ft
8↔20 mesh bentonite crumbles
Depth top of seal: [193.5-ft]
Type of seal: Bentonite pellets
Depth top of sand pack: [197.3-ft]
8↔12-mesh silica sand
Depth top of screen: [199.8-ft]
4-in, #10-slot, stainless steel with channel pack
Depth bottom of screen [221.1-ft]
Depth to bottom of borehole: [222.6-ft]

Drawing By: RKL/2W10-18.ASB Date: 16Apr93
Reference: WHC-SD-EN-DP-041

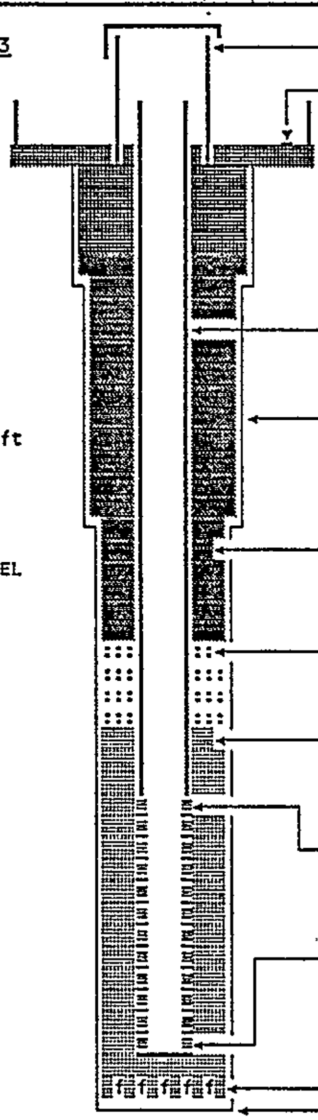
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W11-27
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	TEMPORARY WELL NO:
Driller's Name: D. Kruger/J. Carpenter	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 43,751.5 E/W W 75,482.7
Drilling Company: Kaiser Engineers	Company Location: Hanford	State NAD83 N 136,796.56m E 566,884.97m; Coordinates: N 448,860 E 2,219,730
Date Started: 08Oct91	Date Complete: 21Nov91	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface (ft): 681.81 (Brass cap)

Depth to water: 218.4-ft Nov91
(Ground surface) 220.0-ft 26Mar93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0→3.5: Backfill and SAND
3.5→10: Silty SAND
10→15: Silty sandy GRAVEL
15→20: Sandy GRAVEL
20→25: Sl sandy GRAVEL
25→35: Sl silty sandy GRAVEL
35→40: Sandy GRAVEL
40→80: SAND
80→85: Sl gravelly SAND
85→100: Sl sandy SILT
100→108: SAND
108→120: SAND w/trace CALICHE
CALICHE stringer @ 108-ft
120→125: Sl gravelly SAND
125→130: SAND w/trace SILT
130→150: Sl sandy GRAVEL
150→155: GRAVEL w/trace SAND
155→175: Sl sandy GRAVEL
175→190: Sl silty, sl sandy GRAVEL
190→200: Silty sandy GRAVEL
200→235: Sandy GRAVEL



Elevation of reference point: (top of casing) [685.27-ft]
Height of reference point above ground surface [3.46-ft]
Depth of surface seal [0→17.9-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 1→17.9-ft

I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel

Diameter of borehole,
0→19.7-ft, 13-in nominal
19.7→106.8-ft, 11-in nominal
106.8→235.0-ft, 9-in nominal

Type of filler, 17.9→205.9-ft
8→20-mesh bentonite crumbles

Depth top of seal: [205.9-ft]
Type of seal:
3/8-in bentonite pellets

Depth top of sand pack: [209.7-ft]
20→40-mesh silica sand

Depth top of screen: [213.2-ft]
4-in, #10-slot, continous wrap
T304 stainless steel with
filter pack

Depth bottom of screen: [233.6-ft]

Fill, 234.0→235.0-ft
Depth to bottom of borehole: [235.0-ft]

Drawing By: RKL/2W11-27.ASB Date: 16Apr93

Reference: __________

9413154.2080

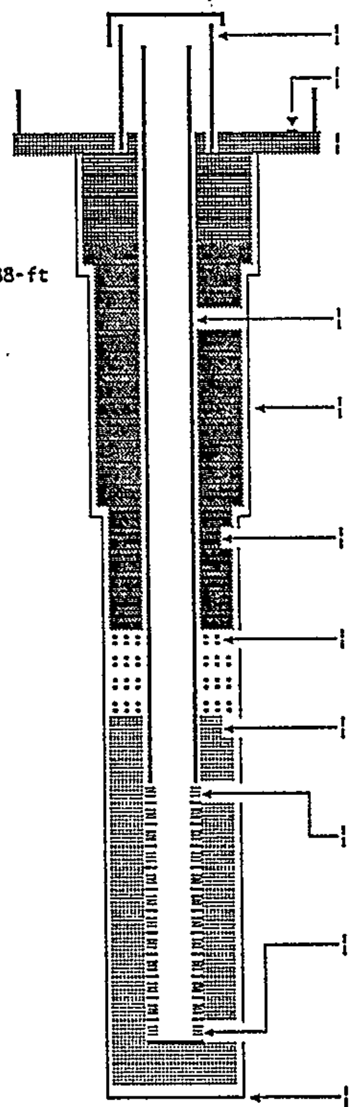
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W11-28 TEMPORARY WELL NO:
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 43,577.8 E/W W 75,319.3
Driller's Name: H. Baker	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 136,743.74m 448,686 E 566,934.89m 2,219,894
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 03Oct91	Date Complete: 11Dec91	Elevation Ground surface (ft): 689.94 (Brass cap)

Depth to water: 226.5-ft Dec91
(Ground surface) 228.4-ft Oct92

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0-5: Sandy GRAVEL
5-10: SAND
10-40: Sandy GRAVEL
40-75: SAND
75-80: Gravelly SAND
80-97: SAND, 6-in SILT layer @ 88-ft
97-99: SILT
99-105: SAND
105-110: SILT
110-115: Sandy SILT
115-120: SILT
120-125: SILT W/CALICHE
125-130: Sl silty, sandy GRAVEL
130-140: Sl sandy SILT
140-145: Sandy SILT
145-150: Silty sandy GRAVEL
150-155: Sandy GRAVEL
155-160: Silty sandy GRAVEL
160-165: Silty GRAVEL
165-180: Sandy GRAVEL
180-205: Silty sandy GRAVEL
205-210: Sl gravelly silty SAND
210-215: Sl sandy GRAVEL
215-230: Silty sandy GRAVEL
230-242: Sandy GRAVEL
242-247: Sl gravelly SAND



Elevation of reference point: (top of casing) [693.48-ft]

Height of reference point above ground surface [3.54-ft]

Depth of surface seal [0-18.1-ft]

Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 1-18.1-ft

I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel

Diameter of borehole,
0-20.3-ft, 13-in nominal
20.3-116.2-ft, 11-in nominal
116.2-247.4-ft, 9-in nominal

Type of filler, 18.1-218.2-ft
Bentonite crumbles

Depth top of seal: [218.2-ft]
Type of seal:
Bentonite pellets

Depth top of sand pack: [220.8-ft]
10-20-mesh silica sand

Depth top of screen: [224.0-ft]
4-in, #10-slot, continous wrap
T304 stainless steel with
filter pack

Depth bottom of screen: [244.9-ft]

Depth to bottom of borehole: [247.4-ft]

Drawing By: RKL/2W11-28.ASB   Date: 16Apr93

Reference: ____________

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: 200 W Water Supply
Driller's Name: K. Olson
Drilling Company: Kaiser Engineers
Date Started: 17Sep91

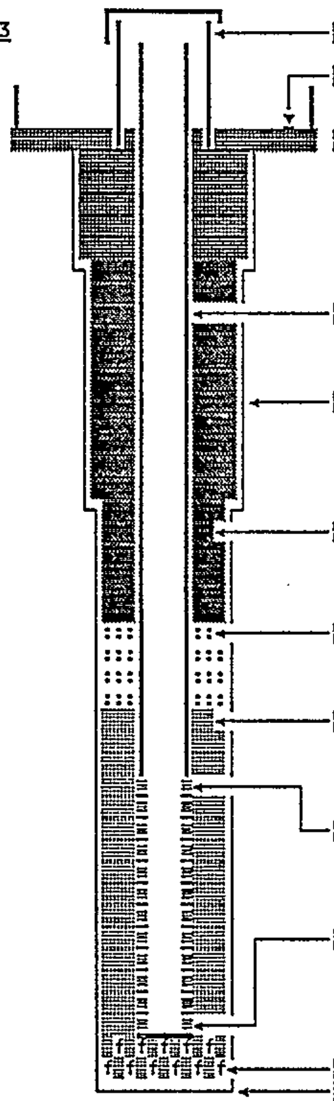
Sample Method: Drive barrel Hard tool
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 04Nov91

WELL NUMBER: 299-W14-12
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 42,070.0 E/W W 75,418.9
State NAD83 N 136,284.17m 566,905.69m
Coordinates: N 447,178 E 2,219,798
Start Card #: Not documented T___ R___ S___
Elevation Ground surface (ft): 667.08 (Brass cap)

Depth to water: 201.2-ft Nov91
(Ground surface) 203.0-ft 26Mar93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔10: FILL-sandy GRAVEL
10↔15: Sl gravelly SAND
15↔20: SAND
20↔34: Sandy GRAVEL
34↔94: SAND (Clayey sandy SILT lens @ 57-ft)
94↔102: Sandy SILT
102 : CALICHE layer
102↔110: Sl gravelly sandy SILT ($CaCO_3$ cemented)
110↔126: Gravelly sandy SILT ($CaCO_3$ cemented)
126↔205: Sandy GRAVEL (Venting CCl_4 @ 142-ft)
205↔215: Sl silty gravelly SAND
215↔222.5: Sl silty sandy GRAVEL



Elevation of reference point: [670.52-ft]
(top of casing)
Height of reference point above ground surface [3.44-ft]
Depth of surface seal [2↔19.5-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad
4 equidistant protective posts
Cement grout 2↔19.5-ft
I.D. of riser pipe: [4-in]
Type of riser pipe: Stainless steel
Diameter of borehole,
0↔19.5-ft, 13-in nominal
19.5↔160.0-ft, 11-in nominal
160.0↔222.5-ft, 9-in nominal
Type of filler, 19.5↔190.5-ft
8↔20-mesh bentonite crumbles
Depth top of seal: [190.5-ft]
Type of seal:
3/8-in bentonite pellets
Depth top of sand pack: [194.8-ft]
20↔40-mesh silica sand
Depth top of screen: [198.4-ft]
4-in, #10-slot, continous wrap
T304 stainless steel with
filter pack
Depth bottom of screen: [218.7-ft]
Fill, 218.7↔222.5-ft
Depth to bottom of borehole: [222.5-ft]

Drawing By: RKL/2W14-12.ASB Date: 16Apr93
Reference:

9413151.2081

9413154.2082

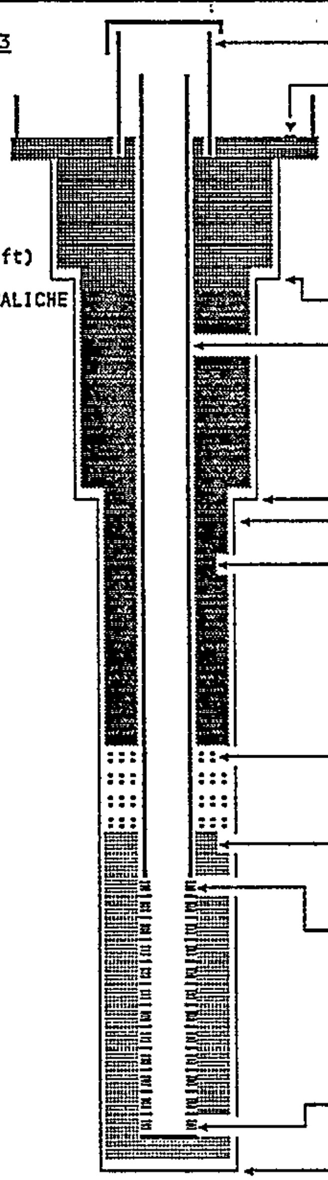
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-W15-22 TEMPORARY WELL NO: None
Drilling Fluid Used: 200 W Water Supply	Additives Used: None	Hanford Coordinates: N/S N 41,504 E/W W 76,150
Driller's Name: G Thomas/C Wamsley B Strode/L Watkins	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 136,111.19m 446,610 E 566,683.32m 2,219,069
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 15Nov90	Date Complete: 16Jan91	Elevation Ground surface (ft): 667.71 Brass cap

Depth to water: 198.1-ft Dec90
(Ground surface) 202.4-ft 26Mar93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0↔5: (Backfill)
5↔30: Silty sandy GRAVEL
30↔47: Sandy GRAVEL
47↔102.5: SAND
(4-in SILT lens, 69.7↔70-ft)
102.5↔110: SILT
110↔123: Gravelly silty SAND w/CALICHE
123↔124.5: Silty SAND w/CALICHE
124.5↔126: Silty SAND
126↔221.9: Silty sandy GRAVEL
(Cemented @ 137-ft)



Elevation of reference point: (top of casing) [670.77-ft]
Height of reference point above ground surface [3.06-ft]
Depth of surface seal [0↔19.0-ft]
Type of surface seal: Pre-mix concrete
4x4-ft x 6-in surface pad to 2.7-ft
4 equidistant protective posts
Cement grout, 2.7↔19.0-ft
13-in nominal hole to 17.9-ft
I.D. of riser pipe: [4-in]
Type of riser pipe:
Stainless steel
Diameter of borehole,
17.9↔150.6-ft, 11-in nominal
150.6↔221.9-ft, 9-in nominal
Type of filler, 19.0↔186.1-ft
8↔20 mesh bentonite crumbles
Depth top of seal: [186.1-ft]
Type of seal:
Bentonite pellets
Depth top of sand pack: [192.3-ft]
8↔12-mesh silica sand
Depth top of screen: [198.5-ft]
4-in, #10-slot, stainless steel
with channel pack
Depth bottom of screen [219.8-ft]
Depth to bottom of borehole: [221.9-ft]

Drawing By: RKL/2W15-22.ASB   Date: 19Apr93

Reference: WHC-SD-EN-DP-041

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9413154.2083

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